Project Test-4-SME's overall report on regional mapping of SME's

Action: 3.1 Analyze demand for testing among SMEs and existing services in the region

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CONTENT

Summary

Within the framework of the TEST-4-SME project, companies and enterprises, operating in the field of electronics and electronic equipment, were interviewed. The purpose of the survey is to analyze and identify the needs of small and medium-sized enterprises in testing electronic products and / or equipment in the Baltic Sea region. In total, a link to the questionnaire was sent to **383** companies, which work in this field. **118** companies from Latvia, Lithuania, Estonia, Finland and Germany completed and submitted the questionnaire. Mainly the interviewed companies filled in the questionnaires in the native language of the country. The obtained data were analyzed and, at the end of the survey, based on the responses received, a statistical analysis of the results was compiled. The data were checked and analyzed by the project partners and all the survey data were compiled into a database. The report is developed in English and includes 27 pages.

1. SURVEY METHODOLOGY

1.1. General objective of the survey

The survey was conducted for the development of innovative network including testing laboratories offering their support for interested enterprises, participating in production of electronics and electronic equipment market. Within the framework of this network, which operates in the Baltic Sea region, enterprises will be supported, knowledge and experience will be shared between laboratories to ensure the conformity of the products produced at enterprises, with the requirements set out in international standards. This check for conformity should occur at the early stages of product creation and the established network will provide competent advice for production, to personnel, as well as for testing the methods themselves.

The purpose of the survey is to analyze and identify the need for small and medium-sized enterprises to test electronic products and / or equipment in the Baltic Sea region. The survey was conducted from October 1 – December 31, 2018.

The main criterion for the selection of the SMEs was the scope of its activities – it should be involved in the production of electronics, electronic devices or parts for these devices. The survey was sent to the companies that differ in annual turnover, number of employees and date of establishment including Larger companies, Medium enterprises and Small enterprises. The enterprises are mainly engaged in the production of electronics and electronic equipment

of a very different spectrum. In total, the electronic link to the questionnaire has been sent to **383** companies working in the field of electronics and electronic equipment in the Baltic Sea Region. In total of **247** of the contacted companies started to fill the questionnaire but not all have completed it, finally **118** companies have fully completed and submitted the questionnaire.

1.2. Methods of conducting the questioning

Questionnaire was developed within the project activity A 3.1 with contribution of all the Project partners and translated in 6 languages. Afterwards the questionnaire was uploaded to the online survey platform and the links to the questionnaire was distributed to potential SMEs. However, since some companies were contacted via telephone or during, face to face meetings, personal contacts and training events, therefore, the printed versions were provided to the representatives of the SMEs as well. Electronic, written and oral methods were employed within the questionnaire, such as via email – link to the questionnaire's electronic version, by phone and by conducting interviews directly with representatives of the organizations. This report includes the accumulated results of all the answers provided.

The questionnaire was filled anonymously, and no one else, except for a representative of the Project, could see the answers. The survey itself is completely confidential and the data obtained were not transferred to third parties. Participation in the survey is voluntary, and if the interviewee did not want to answer the question, he or she could skip it.

1.3. Design of the questionnaire

Questionnaire form included 13 questions (see Annex 1) and was developed within the project activity A 3.1 with contribution of all the Project partners. Online questionnaire in 6 languages was developed by Hochschule Wismar, University of Applied Sciences: Technology, Business and Design and uploaded to the online survey platform[2]. Full questionnaire is available at https://ww2.unipark.de/uc/Test4SMEsurvey/ and in Annex 1 of the report.

2. RESULTS OF THE SURVEY

2.1 Summary of survey

The data from each company were compiled into a database. The results are presented by percentage of respondents and, in some questions, by each respondent individually**. *Of the 118 companies that provided the answers, most of them were small, medium sized (56%) and micro enterprises (36%), the other (8%) were large companies.*** In replies on the question about the ***date of establishment*** of the enterprise, among companies that responded 7% were founded 0-1 year ago, 15 % - 2-5 years ago, 16 % enterprises were founded 5-10 years ago, 62% answered that their enterprise has been operating for more than 10 years.

2.2 Analysis of geographical scope of the enterprises

Through analysis of the ***geographical scope*** of the enterprises, most of the interviewed companies indicated an international level - which is 63 % of all responses received. Among those mentioned were the Baltic countries and the countries of the European Union as a whole, particularly Germany, the Netherlands, Scandinavia and Italy were indicated. Other representatives replied that their company cooperates with countries such as the USA, Belarus, Georgia, Russia, Ukraine, Canada, China and even Palestine. The remaining 30 % companies are working at the national level and 7 % of companies work at the local (regional) level.

2.3 Indication of scope of the enterprises

Companies also indicated ***scope of their business (Fig.1)***. Thus, 44 interviewees (37 %) answered that their company operates in the field of electronic devices; such areas as Materials for Electronical Systems, ICT technologies, Research. "**Parts, components and/or pieces for electronical devices**" was noted in 12 questionnaires (10 % of the total number of responses received). **Computing, ICT technologies, research and development** was only noted in 5 questionnaires (4%). **Materials for electronical devices** was noted in 3 questionnaires (2%) and **Materials for protection from electromagnetic field** was noted with 2 questionnaires resulting 2%. The most of the business (55%) was in several other fields as heath technology, cables and wiring systems, micro pumps, robotics, IT and software, heat pumps, electronic drive technology, installation of electronic equipment, network operation, flight seats, flight technology, solar modules, solar power plants, process control and automation, laser

micro/nano fabrication technologies, scientific research on natural sciences and engineering, characterization, testing of batteries, solar cells & electrical systems and shock & vibration testing, electronical control systems for mobile machinery and HPAC industry.

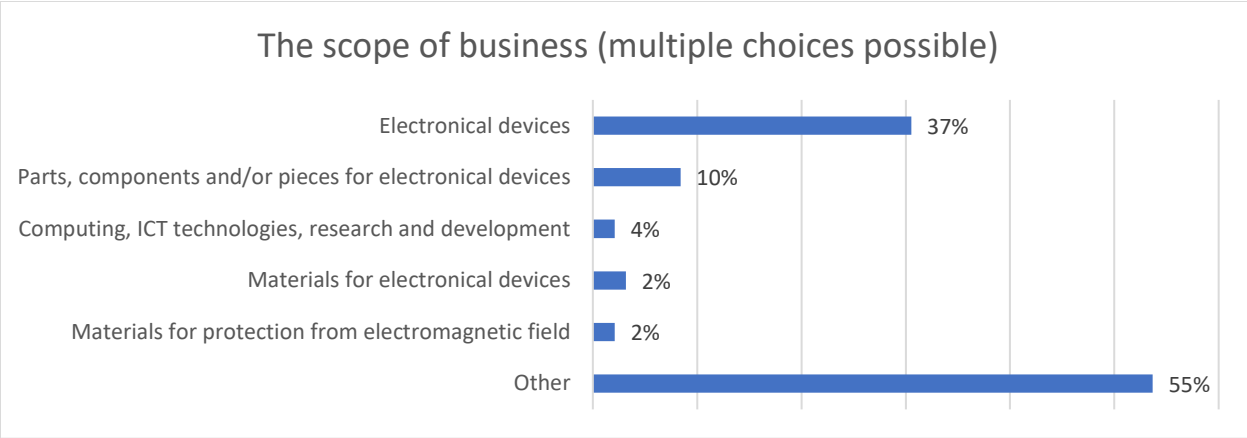

Figure 1. Scope of business (multiple choices possible)

2.4 Product testing laboratory services

When asked whether companies use ***laboratory services to test their products***, 72 responses (61%) answered in the affirmative. The companies indicate the services of LEITC (Latvian Electronic Equipment Testing Centre, Latvia), Rodger Labs, TUF (Germany), DEKRA (Netherlands), CITECOM, TestLab (Poland), ORS, TRAD (Tests and Radiations, France), Alter Technology (Spain), DFI (Dechema Forschungsinstitut, Germany), Inspecta, Wismar University, Tartu Observatory, RISE (in Sweden), TTU laboratories, Rauma EMC laboratory, Verkotan and Cetecom. Part of companies mentioned that they use any lab service's that can offer service needed and they haven't permanent service provider.

The next question asked whether companies know about the ***available testing services in their area to test their products***. The 71 answers (60 %) were positive.

2.5 The standards indicated by companies

The companies indicate the standards, to which company's products must comply in order to receive a certificate of conformity, most of the participants have mentioned the followed standards:

ISO - International Organization for Standardization: ISO9001.

CC - The Common Criteria for Information Technology Security Evaluation.

FCC - Food Chemicals Codex.

ETSI - The European Telecommunications Standards Institute.

DIN - Stands for "*Deutsches Institut für Normung*", meaning "German institute for standardisation": DIN EN 60825-1, DIN 9000.

IEC - Electrical installation rules, standarts: IEC50160, IEC61730:2016, IEC61215, IEC61730, IEC 61439-1:2011as, IEC 60825, IEC 61215:2016.

FDA - Register with the U.S. Food and Drug Administration): 21CFR 1040-10, FDA21CFR 1040-11.

EN - European Standards (abbreviated ENs owing to the more literal translation from French/German as European Norms) are technical standards drafted and maintained by

1) ***CEN*** - *European Committee for Standardization,*
2) ***CENELEC*** - *European Committee for Electrotechnical Standardization,*
3) ***ETSI*** *European Telecommunications Standards Institute*.

The vast majority of devices that contain or use electronic or generate electricity relies on ***IEC*** *International Standards and Conformity Assessment Systems* to perform. Standards protect consumers and make sure that products work together safely and as intended. They are also needed by test labs to check that products are safe to use; governments rely on them to protect citizens from unsafe products, like mentioned by customers: EN-54, EN-55032**,** EN 300 220, , EN 50470-3, EN 62052-31:2016, EN 6231 1:2008, EN 301 489-3 V2.1.1, EN 301 489-1, EN 61347-2-11:2001, EN 61347-1:2015, EN 60598, EN 55022, EN 61000, EN 55011, EN 50022 and biodegradable products according to EN 13432.

IRMM - The Institute for Reference Materials and Measurements is one of the seven institutes of the Joint Research Centre (JRC), a Directorate-General of the European Commission (EC).

MIL- STD and MIL-SPEC - United States defence standard, often called a military standard, "***MIL-STD", "MIL-SPEC", or (informally) "MilSpecs"***, is used to help achieve standardization objectives by the U.S. Department of Defence.

FCC - required by the National Environmental Policy Act of 1969, among other things, to evaluate the effect of emissions from ***FCC****-regulated transmitters on the quality of the human environment*. Several organizations, such as the *American National Standards Institute* ***(ANSI)***, *the Institute of Electrical and Electronics Engineers, Inc.* ***(IEEE)***, and the *National Council on Radiation Protection and Measurements* ***(NCRP)*** have issued recommendations for human exposure to RF electromagnetic fields.

VDE - the electrotechnical ***DIN standards*** issued by the ***DKE*** *(Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE - www.dke.de*) are part of the German standards collection. These electrotechnical safety standards receive a VDE classification number and are included in *the **VDE** Specifications Code of Safety Standards*.

BEAB - Approved Mark from Intertek is a European Safety Mark used by leading electrical manufacturers to support CE Marking and to demonstrate conformity with the *Low Voltage Directive (**LVD**).*

ETSO - European Technical Standard Order: *ETSO-C127*.

TSI - The true strength index is a technical momentum indicator that helps traders identify short-term price swings while trading in the direction of the trend. The indicator is useful for determining overbought and oversold conditions of a security by incorporating the short-term momentum of the market with the lagging benefits of moving averages.

EMC Directive - *The Electromagnetic Compatibility* (EMC) Directive 2014/30/EU ensures that electrical and electronic equipment does not generate, or is not affected by, electromagnetic disturbance.
CE - The letters 'CE' appear on many products traded on the extended Single Market in the *European Economic Area (**EEA**)*. They signify that products sold in the EEA have been assessed to meet high safety, health, and environmental protection requirements. When you buy a new phone, a teddy bear, or a TV within the EEA, you can find the CE mark on them. CE marking also supports fair competition by holding all companies.

However, depending on the specifics of the enterprise, the standards, to which the products comply, are different. For example, the following standards were mentioned: ***IEC*** 60335 (USA, Canada) and ***IN*** 60335-1; ***EN*** 60335-2-6 (Europe, Asia). ***Certificates FCC, CE, ROHS and QI*** – these standards are needed by electronical products.
There were also questionnaires, in which specific standards were indicated, the following codes were written –***MIL-STD***-1275, ***EMC***, ***SAR, LVD, IPC/WHMA*** 610&620.

2.6 Institutions for final testing of new products

In the question about **institutions for final testing**, it was proposed to indicate the names of the laboratories in which the company is testing its products. The laboratory *LEITC is* most often mentioned, the laboratory *TUV Nord/Alter Technology*, *Inspecta, RISE, FIMKO, BACL, BV and underwriter laboratories, Engery, CEcert, Dekra, Wismar University, SGS, Dynamic test center, TUV Rheinland GMbh, Fraunhofer ISE, ISC-Konstanz, JSC, Bureau Veritas Lit", Latvian Electronic Equipment Testing Center, KIWA-zertifikat and Communications Regulatory Authority of the Republic of Lithuania* certificate services to get the certificate of conformity and to put the product on the market. In turn, 38 % of respondents indicated that they do not use the services of laboratories or their products have already passed the necessary checks and have been successfully certified.

2.7 Testing needs of companies and of availability of testing infrastructure

Indicating opinion of companies regarding ***testing needs and level of availability of testing infrastructure*** in the BSR we present different opinions accumulated by project partners from all countries involved into implementation of the project:

Estonian partners revealed that currently the biggest problem seems to be that most of companies do not know what to test and where to test. There are a few laboratories that are used for testing but if more information would be available on testing services, the company and testing service provider would find each other easier. Market demand for the services that the participants stated were not available in the region and this issue should be analyzed. Estonian partners indicated that if possible and required, services that are yet not provided in the region (characterization & testing of batteries, solar cells & electrical systems) should be made available for companies. It should be noted that as an alternative to development of technologies for testing of solar cells & electrical systems in Estonia solar cells testing service is currently available in Lithuania. TEST-4-SME is currently solving some of the gaps by informing companies what testing services are available and where. Consultations are also given to companies to give a better overview on what tests have to be performed on specific products.

Wismar University pointed that the focus should be on providing the missing services as an example Electromagnetic compatibility, EMC testing capabilities, Fine motor testing micro tests Nano technological tests, High power laser testing, transnational IT security, network analysis and aviation technology. These missing services should be developed and offered by testing laboratories to attract more customers and to have a solid stand in the market. Furthermore, we should also provide a focused intensive course for the laboratory workers, since their qualification is important to most of the customers. Lastly, to increase attraction to testing services, service price should be slightly below the other service providers in the BSR. Having fulfilled these missing gaps will grant us a great success in the market, increase the testing mechanism and develop an innovative culture that focuses on testing services to compete in the market. Lastly it will create services that are fully tested and fully qualified to be a great competition against the international provided services in the European Union and other regions.

In Latvia the number of companies interviewed and analyzed gives an overview of the availability of testing infrastructure and services in the region as well as identifies weaknesses in the region, including technical competence or lack of necessary equipment. Improvement of availability of testing infrastructure should be made for such types of testing, as climatic testing, shock & vibration testing, manufacturing processes verification and characterization & testing of batteries, solar cells & electric systems. It is important to improve the information flow and availability to ensure the awareness of SMEs about testing services in the region. To reach this goal, a useful tool is being created – a data base of testing services in the Baltic Sea Region where each company could find the closest and most accessible services.

According to the answers of **Finnish companies**, it could be seen that the testing companies are lacking are partly services that are available such as climate testing, material composition

analysis, environmental and vibration testing. This indicates that companies are not always aware of the analysis/testing services provided in Finland. The other reason for "lack of certain infrastructure" could be the special testing needs (e.g. very specific product). Also, the lack of accreditation in laboratories was mentioned being missing.

In Lithuania laboratories use testing services to test their product, while fairly large percentage (29%) didn't use testing services. Furthermore, only 64% knew if there are laboratories testing their services in their region. When it comes to the availability and accessibility of the infrastructure in the region, we could notice that there is mostly very good, good or adequate availability infrastructure and accessibility for all the tests mentioned by the partners, except that sound characterization, spectral responsivity of radiometric sensors and bioelectromagnetic testing (on living cells and model organisms) is less than 25% of the respondents interested.

CONCLUSIONS AND RECOMMENDATIONS

This survey presents the overall results of the needs of small and medium-sized enterprises of testing electronic products and/or equipment mainly in the Baltic Sea region. The number of companies interviewed and analyzed gives an overview of the availability of testing infrastructure and services in the region.

Most at surveyed companies have international scope of business. The vast majority of companies work with different scope of businesses and pieces for electronical devices. Not all respondents have knowledge about the available testing services in their area and use laboratories' testing services to test their products.

The needs and availability of testing infrastructure for several types of testing was revealed. Considering only those tests in which companies feel the need and which have adequate availability of testing infrastructure, the highest percentage was obtained by testing the electromagnetic compatibility, electroconductivity/resistivity of materials and material & compositional characterization, testing & analysis, followed by temperature & humidity environmental testing. Accessibility of testing services was rated as adequate and good mostly for electromagnetic compatibility, material & compositional characterization and manufacturing processes verification.

In general, by summarizing the questions – about availability of testing infrastructure and accessibility of testing services, enterprises, on average, positively assessed the level of services offered and, rather, medium and lower - the level of the proposed infrastructure. Improvement of availability of testing infrastructure should be made for such types of testing, as climatic testing, shock & vibration testing, manufacturing processes verification and characterization & testing of batteries, solar cells & electric systems.

Currently the survey showed that part of companies does not know what to test and where to test, not fully aware the importance of testing the new products, ensuring product quality and safety and reducing the costs of putting it on the market. There are a few laboratories that are used for testing but if more information would be available on testing services, the company

and testing service provider would find each other easier. Therefore, it is important to improve the information flow and availability of the missing services to ensure the awareness and the participation of SMEs about testing services in the region. To reach this goal, a useful tool should be created – **a data base of testing services in the Baltic Sea Region** where each company could find the closest and most accessible services. Lastly, consultation should also be given to companies to give a better overview on what tests have to be performed on specific products.

4. ANNEX

4.1 Test4SME's Estonia Survey Analysis

Project: Test-4-SMEs
Activity: 3.2 Identify gaps within the region (in cooperation with A3.1 & 3.2)
Subtask: **Questionnaire Results**
Date: 06.02.2019
Country: Estonia
Produced by: University of Tartu, Tartu Observatory

The scope of the SMEs activities

The survey for electronics SME's was filled in by 44 SMEs from Estonia. To get SME's to participate in the online survey, the survey questions were printed out on paper and given to SME's to fill in on two SME training events in Estonia. One training event was held in Tartu, Tõravere (Tartu Observatory) and the other took place in Tallinn. Most of the surveys were filled in during the training events. The SME's seemed to have a quite positive attitude towards filling the survey, but when analyzing the results, there were a few questions without answers. It might indicate that the survey was too long.

The structure of companies and their product testing requirements

The electronics SME's market in Estonia is dominated by 86% of Micro & Small and Medium sized companies. Only 14% of the companies that filled in the survey were large electronics companies. Many large electronics companies probably did not participate in this survey because the training events were focusing on getting small and medium sized enterprises to participate. 59% of the companies who answered the survey were established more than 10 years ago. Only 6% of the companies were established less than a year ago. The companies are working equally in national and international geographic regions. It was noted that 55% of the companies use laboratory services to test their products. The laboratories that are mentioned most are Inspecta, Tartu Observatory, RISE (in Sweden), TTU laboratories, Rauma EMC laboratory, Verkotan and Cetecom. Testing services which according to participants are not available in Estonia are characterization & testing of batteries, solar cells & electrical systems and shock & vibration testing. Testing services with very low or low accessibility are characterization & testing of batteries, solar cells & electrical systems, electromagnetic compatibility testing and testing of electroconductivity/sensitivity of materials.

The identification of gaps in testing services in region

To understand the gaps, we asked our participants several questions and this table describes their answers.

Topic asked	Answers
Which testing infrastructure is partly or completely missing in the reasonable proximity of your company	Mechanical resistance tests, climatic tests for wood pieces (longer than 50 cm), radio communication, GSM, Bluetooth and WiFi tests, electromagnetic compatibility testing, ultrasonic cavitation.
Specify the reasons of low availability of testing infrastructure in your region.	59% of the participants indicated that lack of companies who need the testing services and 27% indicated that the lack of specialists of high quality is the reason for low availability of the testing infrastructure. It was also stated that clients are not interested in testing services and it is difficult to find exactly what testing services are provided in Estonia.
Specify the reasons of low accessibility to the required testing services in your region.	39% of the participants answered that the low accessibility to the required testing service in their region was due to the low awareness of the utilization. Other reasons such as lack of information, devices, experience and companies who need testing services was pointed out.
Name the standards your product should meet in order to receive certificate of conformity.	Standards that were stated are EN 55022, EN 61000, EN 55011, EN 50022, MIL-STD-1275, EMC, SAR, LVD, IPC/WHMA 610&620, ISO 13485.
Name the institutions whose services you are using for final testing to get the certificate of conformity and to put the product on the market.	The participants stated that they mostly use Inspecta, RISE but also Fimko, LEITC, BACL, BV and Underwriter laboratories. One participant mentioned that the company is looking for partners where to test their products.

Currently the biggest gap seems to be that companies do not know what to test and where to test. There are a few laboratories that are used for testing but if more information would be available on testing services, the company and testing service provider would find each other easier. Market demand for the services that the participants stated were not available in the region should be analyzed. If possible and required, services that are yet not provided in the region (characterization & testing of batteries, solar cells & electrical systems) should be made available for companies.

TEST-4-SME is currently solving some of the gaps by informing companies what testing services are available and where. Consultations are also given to companies to give a better overview on what tests have to be performed on specific products.

4.2 Test4SME's Latvia Survey Analysis

Project: Test-4-SMEs
Activity: 3.2 Identify gaps within the region (in cooperation with A3.1)
Subtask: **Questionnaire Results**
Date: 15.01.2019
Country: Latvia
Produced by: Riga Technical University

The scope of the SMEs activities

The main criterion for the selection of the SMEs was the scope of its activities – it had to be connected with the production of electronics, electronic devices or parts for these devices. The survey involved companies that differ in annual turnover, number of employees and date of establishment. For example, recently established companies, such as Catchbox Ltd. (established in 2014), EMI Electronics Ltd. (established in 2014) AdvanGrid Ltd. (established in 2015) were asked to fill out the questionnaire. Examples of larger companies, the history of which begins even in the beginning of the previous century, include, RER Ltd. (Riga Electric Machine Building) and RRR Ltd. (VEF Radiotehnika RRR), as well as JSC Latvenergo (1991), JSC Jauda (1991), JSC Rebir (1991), JSC Hanzas Elektronika (1999), JSC SAF Tehnika (1999) and many other companies, which hold leading positions in the electronics and electronic device market in Latvia. During the exhibition "TECH INDUSTRY 2018", that took place in Riga (Latvia) on 29 October-01 November 2018, the questionnaire was distributed to such companies, like Argus RT Ltd., Silmor Ltd., Keramserviss Ltd., Euroled Ltd., EMT Ltd., but also to the companies, working on bigger market or daughter-companies, whose offices locate in Latvia as well - JSC Ditton, Hidrobalt Ltd., Phoenix Contact Ltd. and Bibus Baltics Ltd. These enterprises are mainly engaged in the production of electronics and electronic equipment of a very different spectrum, for example, audio and lightning systems, electric equipment for trains, urban transport and dump trucks, pneumatic, hydraulic, mechatronic and environmental technology equipment and accessories.

The structure of companies and their product testing requirements

The data from each company were compiled into a database. Results are presented by percentage of respondents and, in some questions, by each respondent individually. Most from respondents - 9 enterprises (56 % of the respondents) are small and medium size companies - their annual turnover does not exceed 50 million euros. The other 7 companies surveyed are micro-enterprises. There are no large companies among the respondents to the survey. In replies on the question about the date of establishment of the enterprise, 7 companies responded that they were founded 2-5 years ago (44 %). These companies can rightly be called young enterprises, just entered the market of electronics and electronic equipment and, as a result, those who may need to test products for compliance with standards. None of the

responding enterprises were founded during this or last year. Through analysis of the geographical scope of the enterprises, most of the interviewed companies indicated an international level - which is 69 % of all responses received. The participants provided a detailed answer to this question by providing information on with which countries they cooperate. Among those mentioned were the Baltic countries - Lithuania and Estonia, and the countries of the European Union as a whole, and in particular Germany, the Netherlands and Italy were indicated. Three representatives replied that their company cooperates with countries such as the USA, Belarus, Ukraine, Canada, China and even Palestine. Geographical scope of business: from international companies, we can safely say that they all work with countries of the European Union. The remaining companies, that provided an answer to this question, were divided as follows – 12 % of them work at the local (regional) level and 19 % at the national level. In the answers on question "Scope of business" the respondents had an opportunity to specify several answers. Thus, 14 interviewees (88 %) answered that their company operates in the field of electronic devices; such areas as Materials for Electronical Systems, ICT technologies, Research and Development account for two answers (13 % for each category). Area "Parts, components and/or pieces for electronical devices" was noted in 5 questionnaires (31 % of the total number of responses received). When asked whether companies use laboratory services to test their products, 10 responses (62 %) were in the affirmative. Other Materials for protection from electromagnetic field Materials for electronical devices Computing, ICT technologies, research and development Parts, components and/or pieces for electronical devices Electronical devices, Computing, ICT technologies, research and development Parts, components and/or pieces for electronical devices, materials for protection from electromagnetic field materials for electronical devices, electronical devices.
Total availability of laboratories' testing services in area: the received answers are similar to results of the previous question - 10 answers (62 %) are positive and the same laboratories are indicated in the total list. Regarding testing needs and level of availability of testing infrastructure, such testing types as electromagnetic compatibility, characterisation & testing of batteries, solar cells & electrical systems, temperature & humidity environmental testing, bioelectromagnetic testing (on live cells and model organisms) and shock & vibration testing were indicated by mark "complete shortage". When analysing the results obtained in general, the availability of the testing infrastructure was noted, for the most part, by poor accessibility and adequate accessibility. But a large share of answers also fall on such an option as "not interested in this type of testing". 62% said yes and 38% said no regarding testing needs and level of availability of testing infrastructure. Considering only those tests in which companies feel the need and which has adequate availability of testing infrastructure, the highest percentage was obtained by testing the electromagnetic compatibility, electroconductivity/resistivity of materials and material & compositional characterization, testing & analysis (38 %), followed by temperature & humidity environmental testing (25 %). In a very good availability 13 % indicated temperature & humidity environmental testing. Poor availability was indicated for such types of testing, as shock & vibration testing (38 %) and climatic testing (31 %), followed by manufacturing processes verification and characterization & testing of batteries, solar cells & electric systems (25 % each).

The identification of gaps in testing services in region

Topic asked	Answers
Which testing infrastructure is partly or completely missing in the reasonable proximity of your company	Respondents named such areas, as: specific material testing, low speed electric transport certification, testing according to MID and 2014/53/EU directive, solar, salt test, thermal shock test, climate testing, mechanical structure testing, vibration testing, digital testing of prototype wiring, different electrical resistance testing, Residual Gas Analysis, total ionization dose test, Single Event Effect. Some questionnaires also noted the absence of any competent consultations and seminars regarding product testing, testing infrastructure and testing services provided on the market.
Specify the reasons of low availability of testing infrastructure in your region.	As the main reason was mentioned the option "lack of companies which need the testing services" (69 %), followed by "lack of qualified specialists, who could perform the testing", scoring 50 % of total answers. In two questionnaires (13 %) the option "other" was chosen, with the following comments indicated - "not using testing services" and "lack of competent expert advice/assessment".
Specify the reasons of low accessibility to the required testing services in your region.	Most often noted was the option "Low awareness of the utilization rules/frames of the available infrastructure" (63 %), followed by option "High (rental) cost" (31 %), restricted or limited accessibility imposed by owner of the required testing infrastructure" (25 %) and "High utilization rate of the required testing infrastructure, long waiting timing" (13 %). In two questionnaires the option "other" was marked: "There are not enough companies, which we would be aware of, offering such services" and "it should be known to testers, not to the users of these services".

Name the standards your product should meet in order to receive certificate of conformity.	IEC 60335 (USA, Canada) and IN 60335-1; EN 60335-2-6 (Europe, Asia). Certificates FCC, CE, ROHS and 01 - these standards are needed by electronical products. In turn, in other questionnaire were written such standards, as TSI EN 300220, IEC50160, EN 50470-3, EN 62052-31:2016, EN 62311:2008, EN 301489-3 V2.1.1 and EN 301489-1. There were also questionnaires, in which specific standards were indicated, the following codes were written - EN 61347-2-11:2001, EN 61347-1:2015 and EN 60598. In the rest of questionnaires standards are mentioned in general - ETSI, FCC, Cc. There were also such questionnaires, in which it was proposed to arrange a seminar, which would describe the required standards and how to comply with them.
Name the institutions whose services you are using for final testing to get the certificate of conformity and to put the product on the market.	For example, companies cooperate with such companies as LEITC (Latvian Electronic Equipment Testing Centre, Latvia), Rodger Labs, TUF (Germany), DEKRA (Netherlands), CITECOM, TestLab (Poland), ORS, TRAD (Tests and Radiations, France), Alter Technology (Spain), DFI (Dechema Forschungsinstitut, Germany).

In general, by summarizing the questions - about availability of testing infrastructure and accessibility of testing services, enterprises, on average, positively assessed the level of services offered and, rather, medium and lower - the level of the proposed infrastructure. Improvement of availability of testing infrastructure should be made for such types of testing, as climatic testing, shock & vibration testing, manufacturing processes verification and characterization & testing of batteries, solar cells & electric systems. **It** is important to improve the information flow and availability to ensure the awareness of SMEs about testing services in the region. To reach this goal, a useful tool is being created - a data base of testing services in the Baltic Sea Region where each company could find the closest and most accessible services.

4.3 Test4SME's Finland Survey Analysis

Project: Test-4-SMEs
Activity: 3.2 Identify gaps within the region (in cooperation with A3.1 & 3.2)
Subtask: **Questionnaire Results**
Date: 28.02.2019
Country: Finland
Produced by: Centria University of Applied Sciences

The scope of the SMEs activities

The companies were search from Centria's own client listing as well as from different sources (lists containing companies working in electrical industry). Total amount of SME's answering the questionnaire was 23. The majority of companies (~91 %) were small or medium sizes; however, one micro and one large company also filled the questionnaire. The companies were contacted by phone first, followed by email, where more information about Centria and TEST-4-SME project was given. The email also had the link to the online survey so the company could easily answer the survey.
The major obstacles were with contacting the companies were the hurry inside the company. The company's representative often promised to answer to the survey when they have time / in a few weeks etc. This of lead to the situation that the survey was forgotten. In general, the companies were interested in the survey and about the services that Centria and TEST-4-SME network could provide. However, in some case the company did not have any need to the services since they classified themselves as retailer.

The structure of companies and their product testing requirements

The companies that answered the survey were typically international SME's that were established more than ten years ago. The scopes of the companies were electronical devices (64%), parts/components for electrical devices (18%) or Computing/ICT tech./R&D (14%). 36% of the companies answering the survey were classifying themselves to the category other (products prepared: heath technology, cables and wiring systems, laser optics, solar thermal collectors, electronics integrated into moulded structures, measurement devices for process industry (pulp and paper, food, chemical), electronical control systems for mobile machinery and HPAC industry). More than 90% of the companies were testing their products, however only 77 % could identify the testing services in their region. The difference in this could be explained the testing made in the company's own laboratories.

The identification of gaps in testing services in region

To understand the gaps, we asked our participants several questions and this table describe their answers.

Topic asked	Answers
Which testing infrastructure is partly or completely missing in the reasonable proximity of your company	According to the answers in the survey, it could be seen that the testing companies are lacking are partly services that are available such as climate testing, material composition analysis, environmental and vibration testing. This indicates that companies are not always aware of the analysis/testing services provided in Finland. The other reason for "lack of certain infrastructure" could be the special testing needs (e.g. very specific product). Also, the lack of accreditation in laboratories was mentioned being missing.
Specify the reasons of low availability of testing infrastructure in your region.	More than half of the answers (56 %) were that the reason for the low availability of services were the "Lack of companies which need the testing services".
Specify the reasons of low accessibility to the required testing services in your region.	The reason for the low accessibility is according to the survey lack of knowledge, but also high costs as well as long waiting times in due to the too high utilization was found to be problematic.
Name the standards your product should meet in order to receive certificate of conformity.	IEC 60384-1, IEC 60384-14 and related standards IEC 60529; IEC60601-1-6:2010 / IEC60601-1-1:2000 IEC 62386-102:2009 /IEC 62386-207:2009; IEC 60068-2 EN 61000-6-2 ;EN 61000-4- 6; EN 61000-3-2:2014 / EN 61000-3-3:2013; EN 55015:2013 / EN 61547:2009 / EN 61347-1:2015 / EN 61347-2-13:2014 / EN 62384:2006 EN 13309:2010; EN ISO 14982:2009; EN 50155 ml EMC (CISPR 16-2-3, CISPR 16-2-1); E/ECE

	Regulation No. 10, Revision 4 (2012); E/ECE Regulation No. 10, Revision 3 (2008) ISO 9227, ISO 25197; ISO 16750-2 – 4; ISO 9806; ISO20957-1:2013; ISO20957-2:2005; AEC-Q200 test standards; UNECE 10.5; MIL-STD-461; EMC ISO 13766:2006 DIN EN 12975; AS/NZS 2712:2017; AS/NZS 2535.1:2007
Name the institutions whose services you are using for final testing to get the certificate of conformity and to put the product on the market.	Some companies told that they use any lab that can offer the service needed and that they don't have permanent service provider. Otherwise companies such as IMQ, SEMKO, SGS Fimko, Centria, Grant4Com, Etteplan, Delta, RI.SE, Dekra and SPF Swirzerland were mentioned. Some company's owning lab facilities were mentioned.

The lack of knowledge about different services (both testing and analysis) is one major gap according to Finland's survey results. The question is whether the lack of information is a larger problem or only problem inside the companies aka the person answering to the survey is not aware of all the services… However, this could be easily solved with more aggressive marketing. The other major problem was the need of the laboratories/service providers that have accreditation. This requires more clients

4.4 Test4SME's Lithuania Survey Analysis

Project: Test-4-SME
Activity: 3.2 Identify gaps within the region (in cooperation with A3.1)
Subtask: **Questionnaire Results**
Date: 05.02.2019
Country: Lithuania
Produced by: Applied Research Institute for Prospective Technologies

The scope of the SMEs activities

To have a clear understanding of the region, Applied Research Institute for Prospective Technologies (ProTech) and its partners in Test-4-SME project had constructed a questionnaire that would create a vision of the demand & the existing electronic laboratory testing services in the region, and also to identify the technological hardware testing services gaps in the Baltic Sea region. ProTech allocated 14 SMEs from the electronics sector to participate in the online survey. The methods used to allocate the SMEs to participate in the online survey were: contacting SMEs by phone, e-mails, and using personal contacts. The main obstacles while allocating participants for the survey were: the need for the companies taking the survey to stay confidential, lack of interest of the purpose of the questionnaire, lack of availability to complete the survey. However, the overall responses from the SMEs to the online survey were positive, and the goal to have a clear understanding of the testing services in the region was well accepted by the participating SMEs.

The structure of companies and their product testing requirements

Through the questions we reached an understanding about the existing services in Lithuania and the service demands that SMEs are looking for. We noticed that the market consists of 50% Micro and 50% Small and Medium sized companies each; none of the large companies have taken the survey. Almost half — 43% — of the companies were established more than 10 years ago, leaving the other half for younger SMEs: 14% for 0-1 years and 2-5 years each, and 29% for 5-10 years of business. It has been noticed that Lithuanian companies are working mostly on international geographic regions — EU countries, Scandinavia, USA, Russia, Georgia, and worldwide — while only 28% of the sample are working on a regional and national base (14% each). It has been noticed that most of the companies (41%) specialized in electronic devices, 18% in parts, components and/or pieces for electronic devices, and 9% — in materials for electronic devices. 27% of the SMEs product scope was labeled as "other": solar modules, solar power plants,

process control and automation, laser micro/nano fabrication technologies, scientific research on natural sciences and engineering; and the remaining 5% — of the companies specialized in the computing, ICT technologies, research and development. 71% of the Lithuanian sample used laboratories testing services to test their product, while fairly large percentage — 29% — didn't use testing services. Furthermore, only 64% knew if there are laboratories testing their services in their region. When it comes to the availability and accessibility of the infrastructure in the region, we could notice that there is mostly very good, good or adequate availability infrastructure and accessibility for all the tests mentioned by the partners, except that sound characterization, spectral responsivity of radiometric sensors and bioelectromagnetic testing (on living cells and model organisms) is really not an interest for the Lithuanian market (less than 25% of the samples interested).

The identification of gaps in testing services in region

To understand the gaps, we asked our participants several questions and this table describe their answers.

Topic asked	Answers
Which testing infrastructure is partly or completely missing in the reasonable proximity of your company	We noticed that the electro-optical devices sector; calibration, characterization and measurement of optical systems; verification of manufacturing processes; vibration & shock testing; testing of photovoltaic modules according to IEC 61215 and IEC 61730; testing of electronics; metrological verification of measurement instruments; characterization and testing of the laser equipment safety class; solar cell and silicon wafer detection and analysis equipment; infrastructure for measuring double-sided and back contact solar cells and modules characteristics are the missing ones.
Specify the reasons of low availability of testing infrastructure in your region.	39% of the participants indicated that the lack of companies which need the testing services, and 28% of the participants indicated that the lack of highly qualified specialists are the reasons for the low availability of the testing infrastructure, and the rest 33% stated (in the option "other") that the available measurement equipment is not adapted to

	the next generation of solar cells and modules, that there are no accredited bodies capable of performing optical measurements, and that the testing infrastructure availability level is sufficient.
Specify the reasons of low accessibility to the required testing services in your region.	30% indicated that the low accessibility to the required testing service in their region was due to the high costs, 28% indicated that it was due to the high utilization rates and long waiting time, 15% stated that it was due to the restricted accessibility of the testing infrastructure, leaving us with 35% of "other" choices: too slow response to the market needs and latest technologies, low demand for the specific measurements, and that the accessibility level to the required testing services is sufficient.
Name the standards your product should meet in order to receive certificate of conformity.	Most of the participants have CE, IEC61215 and IEC61730 as their requirement to receive certificate of conformity. Others stated that the EN-54, IEC 61439-1:2011, IEC 61215:2016, IEC61730:2016, IEC 60825 and EN-55032 are required as well.
Name the institutions whose services you are using for final testing to get the certificate of conformity and to put the product on the market.	We have seen that most of the clients are using the TUV Rheinland GMbh, Fraunhofer ISE, ISC-Konstanz, JSC „Bureau Veritas Lit", Latvian Electronic Equipment Testing Center, KIWA-zertifikat, Communications Regulatory Authority of the Republic of Lithuania certificate services to get the certificate of conformity and to put the product on the market.

The focus should be on the Consortium plans to provide the missing services (if there is such possibility), and on increasing the attraction and availability to the existing testing services (by increasing visibility, lowering prices, etc.).

4.5 Test4SME's Germany Survey Analysis

Project: Test-4-SMEs
Activity: 3.2 Identify gaps within the region (in cooperation with A3.1 & 3.2)
Subtask: **Questionnaire Results**
Date: 15.01.2019
Country: Germany
Produced by: Wismar University

The scope of the SMEs activities

To have a clear understanding of the region, Wismar university and its partners in Test4SME's project had constructed a questionnaire that would create a vision of the demand & the existing electronic laboratory testing services in the region, and also to identify the technological hardware testing services gaps in the Baltic Sea region.
Wismar University had to allocate 21 SME's from the electronics sector to participate in the online survey. These SME's were allocated via a regional search that focused on several SME's that were in the same work field, they were contacted by phone, emails, other project partners in the same field and directly through connections. Wismar University noticed that only 2 participants completed the survey from a total sample of 40 agreed who agreed to participate. After discussion, we realized that the German SMEs fear that their contact is going to be distributed to others and they want to stay anonymous, since they are small then their companies actually test internally and not externally. Therefore, we had to look for more and convince them about our main purpose of the questionnaire.

The structure of companies and their product testing requirements

Through the questions we reached to an understanding about the existing services in the Mecklenburg/ Vorpommern region and the service demands that SME's are looking for we noticed that the market is dominated with 38% of Micro & Small and Medium sized companies leaving 24% of the sample in the Macro sized companies. We noticed that 67% of the companies are established more than 10 years and a growth of 14% are the new comers – less than 1 year, leaving the rest with 19% of the market. It has been noticed that German companies are working equally on national and international geographic regions – Scandinavia, Europe, Russia and worldwide - where only 24% of the sample are working on a local base. It has been noticed that only 2 companies specialized in electronic devices only, 1 company in parts, components or pieces for electronic devices and the rest of the companies had provided intermingle of services to their clients, some other services that they operate in as micro pumps, robotics, IT and software, heat pumps, electronic drive technology, Installation of

electronic equipment, network operation, flight seats & flight technology. One striking result was that only 62% of the German sample used laboratories testing services to test their product. Furthermore, 52% only knew if there are laboratories testing their services in their region. When it comes to the available of the infrastructure in the region, we could notice that the is adequate availability infrastructure and accessibility for all the tests mentioned by the partners but noticed that Bioelectromagnetic testing (on live cells and model organisms is really not an interest for the German market but Nano technology test is also available and accessible in the German market.

The identification of gaps in testing services in region

To understand the gaps, we asked our participants several questions and this table describe their answers.

Topic asked	Answers
Which testing infrastructure is partly or completely missing in the reasonable proximity of your company	we noticed that the Grid load test in the broadband sector, optical tests, Electromagnetic compatibility, EMC testing capabilities, Fine motor testing micro tests Nano technological tests, High power laser testing, transnational IT security, network analysis and aviation technology and loads are the missing ones.
Specify the reasons of low availability of testing infrastructure in your region.	87% of the participants indicated that the lack of high qualified specialist who can perform the testing is the reason for the low availability of the testing infrastructure and the rest said it the niche market and some stated that it is politically.
Specify the reasons of low accessibility to the required testing services in your region.	68% indicated that the low accessibility to the required testing service in their region was due the high cost, 16% indicated that it was due to the owner's restriction, 11% stated that it was due to the high utilization rates and long waiting time leaving us with 5% who had low awareness of the utilization rules.
Name the standards your product should meet in order to receive certificate of	Most of the participants have ISO, DIN, EMC Directive, ISO9001 as their standard

conformity.	requirement for to receive certificate of conformity. Others stated that the FDA 21 CFR 1040-10, FDA 21 CFR 1040-11, DIN EN 60825-1, DIN 9000, VDE, BEAB, IEC, CE, EN and ETSO-C127 are required as well.
Name the institutions whose services you are using for final testing to get the certificate of conformity and to put the product on the market.	we have seen that most of the clients are using the Department of energy, CEcert, Dekra, Wismar University, SGS, Dynamic Test Center are being used to get the certificate of conformity and to put the product on the market.

The Wismar University believes that the focus should be on providing the missing services as an example Electromagnetic compatibility, EMC testing capabilities, Fine motor testing micro tests Nano technological tests, High power laser testing, transnational IT security, network analysis and aviation technology to attract more customers and to have a solid stand in the market, since most of the laboratories are not providing these services. Furthermore, we should also provide a focused intensive course for the laboratory workers, since their qualification is important to most of the customers. Lastly, to increase attraction to our services, our service price should be slightly below the other service providers since most have their focus mostly on the price.

In conclusion, having fulfilled these missing gaps will grant us a great success in the market, increase the testing mechanism and develop an innovative culture that focuses on testing services to compete in the market. Lastly it will create services that are fully tested and fully qualified to be a great competition against the international provided services in the European Union.

IDENTIFICATION OF GAPS IN TESTING SERVICES WITHIN THE BALTIC SEA REGION

WP 3.2. REPORT ON GAPS IN TESTING SERVICES

Final Version

Project:	"Laboratory Network for Testing, Characterisation and Conformity Assessment of Electronic Products developed by SMEs – TEST-4-SME" (ERDF part-financed, Baltic Sea Region Programme 2014–2020) WP3 – Develop Competence Centres Network A.3.2 – Identify Gaps within the Region
Responsible:	PP8 – WU (Hochschule Wismar, University of Applied Sciences: Technology, Business and Design)
Scope:	Delivery Version, WP3.2 Report on Gaps in Testing Services
Working languages:	English
Target groups:	Electronics Producing SMEs and Academic Institutions in the Baltic Sea Region
Author:	Robert Philipp, M.A. robert.philipp@hs-wismar.de
Date of delivery:	29th of April 2019

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Acknowledgment

This paper in hand stands for a compilation of data, its analysis, gradual update and finalisation in the frame of the TEST-4-SME project, part-financed by the ERDF.

Representing the project partner Hochschule Wismar, University of Applied Sciences: Technology, Business and Design, herewith I would like to express by thankfulness to the project Lead partner, who believes in our institution and has granted the access to TEST-4-SME partnership. We hope to continue our fruitful cooperation in the future. My gratitude also goes to the partners and their contribution in the frame of provided information from their own regions that was incorporated in this study and served for further the matic digging. A big thank also goes to project stakeholders and target groups – electronics producing SMEs and academic institutions in the Baltic Sea Region, in particular, for fruitful discussions, exchanged and shared practices and experiences as well as hints given.

This study is funded by the European Union and therefore the access is granted to everybody, who shows interest in testing services.

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1. Introduction

The Baltic Sea Region (BSR) stands for a flagship region in Europe in terms of good economic, social and environmental performance (Gerlitz, Philipp & Beifert, 2017). Following the current 'State of the Region Report' (2017), the BSR generated in 2015 an annual GDP of about 2,000 billion EUR, which is equivalent to 12.5% of the EU-28 economy. Accordingly, the BSR has a forerunner position among the European Regions.

Through intensifying globalisation and arising global networks, new social and environmental challenges have jeopardised innovation and growth opportunities in different markets. Indeed, this is especially true for the SME sector and performance of individual regions in the EU (Prause, Gerlitz & Hoffmann, 2018). Following the European Commission (2018a), more than 99% of all companies in the EU represent micro and SMEs. In 2015, nearly 23 million SMEs generated about 3.9 trillion EUR in value added and are responsible for approx. 90 million jobs, which mirrors an essential source of entrepreneurial spirit and innovation that is essential for the competitiveness of the EU. Therefore, SMEs are regarded as the backbone and driver of regional and national economies. Thus, there is a need to support SMEs and entrepreneurship, since they play a crucial role in generating economic growth, triggering innovations, attracting new investments and businesses, enabling clusters to evolve, ensuring employability and social integration (EC, 2012a; 2013a; 2013b; 2013c; 2015; 2017; Eurostat, 2018; GII, 2018; Prause, Gerlitz & Hoffmann, 2018). Hence, SMEs are also regarded as accelerators for innovative products and services of high quality in the frame of the EU Strategy for the BSR (EC, 2018b).

According to the 'Forecast of Global Electronic Components Players Market 2023' (2018), the electronic components market will grow with a 3.3% CAGR (revenue), which represents 403,100 million US-Dollar by the year of 2023, compared with 331,200 million US-Dollar in 2017. Undoubted this development will also further foster

the employment rate in the electronic component sector in the adjacent countries of the BSR. One of the most important requirements to put new, innovative or mature electronic products on domestic markets or to export them in foreign countries can be seen in the fulfilment of testing standards, which goes hand in hand with numerous certifications that are issued – for instance – through the International Electro-technical Commission (IEC) with the EU/EC Declaration of Conformity for CE Marking (CE), or the Institute of Electrical and Electronics Engineers Standards Association (IEEE-SA), the Inter-National Committee for Information Technology Standards (INCITS) and the International Telecommunication Union (ITU).

In practice, there exist numerous tests in order to determine whether a specific product shows compliance to needed standards, e.g. in case of electronic devices emission, immunity and safety tests, etc. Each of these superordinate testing fields can be quite extensive and broke down in various single testing procedures and measures. In order to ensure trustworthiness in testing results and certification, testing services are offered by many independent institutions or organisations, respectively, and demanded by product manufacturers, developers and designers.

Especially SMEs face challenges in internationalisation due to missing conformity to international product standards. According to the OECD (2009), this circumstance of insufficient match with export product quality, standards and specifications is listed as a top ten barrier for SMEs in the frame of internationalisation efforts. Comprehensibly, in particular in case of new and innovative product developments product testing should occur in early development stages in order to avoid later development failures, which might cause huge costs. On the other hand, particularly early stage product testing (e.g. prototype) causes high costs, which makes it even more difficult for Mirco and SMEs as well as start-ups to take steps in competition with well-established and global players, due to low or missing return in early product development stages. Furthermore, nowadays, testing labs face high demand and, thus exhibit long waiting lists for electronic manufacturers, which in addition leads to increasing inflexibility on

manufacturer side that must rapidly react on fast changing market conditions. In addition, our research results showcase, that especially in the BSR, the accessibility and availability of testing services is not equal distributed in the BSR member states, which may be partly traced back to the lack of knowledge and skills in case of testing standards and procedures; as well as low marketing and promotion activities on laboratories' side and as a result thereof the missing awareness on SMEs' side. All this hinders the sustainable success of electronic products producing SMEs in the BSR.

Accordingly, within the EU-project "Laboratory network for testing, characterisation and conformity assessment of electronic products developed by SMEs" (TEST-4-SME) – part-financed by the ERDF (Baltic Sea Region Programme 2014–2020), companies from BSR countries, who are active in the field of electronics and electronic equipment, were surveyed. The aim of the survey "Mapping Testing Services in Baltic Sea Region" was to identify and analyse the gaps, e.g. technical expertise or lack of hardware, in testing services as well as to clarify SMEs' needs for electronic product or devices testing services in the BSR. The online survey was completed by the participating companies based on experience, knowledge as well as quantitative and qualitative data about their company. A minimum of data about the company was collected in order to analyse the needs of different types of enterprises. The provided data was always treated confidentially and for further purposes aggregated in order to make the data usable for research and scientific purposes only.

This report is structures as follow: In the second chapter, the applied research methodology is presented, which includes an exposition of the data collection procedure, the data analysis measures as well as sample description. Building upon this, the main research results are showcased in the fourth chapter, which embrace a detailed identification and analysis of existing gaps within the BSR in the context of testing services, an analysis of the causally reasons for the perceived low level of availability of testing infrastructure and low level of accessibility of testing services by companies in the BSR, as well as the investigation of the demand for product

standards and testing institution in the region. This report rounds up with a conclusion, which is related to the main findings and as a result thereof some recommendations or concluding remarks, respectively.

2. Methodology

2.1 Data collection

Empirical data collection activities were conducted between the 1st of October 2018 and the 22nd of February 2019, which represents a total data collection duration of about 5 month.[1] The primary target group had been electronic products producing SMEs that are located in the BSR. Accordingly, next to defined SMEs, this includes as well start-ups and micro firms, whereby all of these relevant companies should have a focus on the production of electronics, electronic devices or at least parts of these devices. Nevertheless, the empirical data collection activities were not closed for large companies that are active in the electronic component market. Through the inclusion of larger companies, a comparison group was gathered, in order to identify more profound differences in the testing needs, in contrast to the main target group – SMEs. The geographical scope of the empirical data collection activities was framed through the majority of adjacent BSR countries, namely Estonia, Latvia, Lithuania, Finland and Germany.

Firstly, a survey was elaborated by PP8 (Hochschule Wismar, University of Applied Sciences: Technology, Business and Design), which is directly linked to Activity 3.2 of the EU-project TEST-4-SME (ERDF part-financed, Baltic Sea Region Programme 2014–2020). Accordingly, the objective of the survey “Mapping Testing Services in Baltic Sea Region” was to identify and analyse the gaps, e.g. technical expertise or lack of hardware, in testing services as well as to clarify SMEs' needs for electronic product or devices testing services in the BSR. Therefore, the related data collection activities were targeted to generate primary data.

[1] In some cases, the data collection procedure was finished by the end of the year 2018, since some supporting PPs had already acquired a sufficient sample size in their specific country/region.

The initial developed English version of the survey by PP8 was validated by all PPs from Estonia, Latvia, Lithuania, Finland and Germany, after PP8 had executed the suggestions for improvements, which had been provided by the PPs of the EU-project TEST-4-SME. In a second step, PP8 implemented the English version of the survey on the online survey platform 'Unipark'. This was crucial, in order to further simulate the pre-test or pilot testing, respectively, which was supported again by all PPs.[2] The two-step pre-test of the online survey was conducted to establish content validity from TEST-4-SME PPs from Estonia, Latvia, Lithuania, Finland and Germany. Furthermore, the major focus of the pre-tests was to guarantee clarity, value as well as importance of the survey items. In addition, the pre-test procedures ensured (1) supplementation of aspects that so far have been neglected, (2) verification of the comprehensibility of questions, (3) improvement of the survey regarding structure and design, as well as (4) determination of the needed average time for survey completion (Kromrey, 2016; O'Leary, 2017; Rüdiger et al., 2011). Then, the English version of the survey – which functioned as a template – was translated into five languages (Estonian, Latvian, Lithuanian, Finnish and German language) with support of one previously selected PP per participating country.[3] Afterwards, PP8 also implemented these five language versions of the survey on the online survey platform 'Unipark' and monitored the survey progress during the entire empirical data collection duration.[4] In the latter case, this was communicated through steady progress reports to all PPs.

Thus, the empirical data collection was initially exclusively online-based, whereby the access to the respective online survey was provided via a specific link (five links for

[2] I would like to thank all PPs of the EU-project TEST-4-SME for supporting the pre-test.

[3] PP8 was also responsible for the translation of the online survey in German language.

[4] The entire English version of the online survey was attached to the Appendix A and B of this report.

five language versions of the online survey) to the website, where the five translated versions of online survey had been previously implemented and launched. The invitation to the online survey reached the target group via E-Mails, which was ensured by the support of the PPs. Accordingly, all PPs had been contacted by the task leader (PP8) and asked to forward the invitation to the online survey to potential participants. Therefore, each PP firstly searched for and identified relevant potential participants from and outside its own network in his home country. Building upon this, each PP sent E-Mail invitations to the identified potential participants, which included the respective link to the online survey – differentiated according to the five language versions of the online survey.[5] The following key advantages could be perceived through the online-based data collection: (1) ensuring that the survey was carried out anonymously, (2) exclusion of influencing the respondents due to the survey situation, (3) facilitation of respondents' time-based flexibility, and (4) generation of an adequate sample (Döring & Bortz, 2016; Diekmann, 2007; O'Leary, 2017; Schnell, Hill & Esser, 2004). Possible disadvantages of the online-based survey could be reduced or eliminated. For instance, in order to prevent misuse in the form of a multiple participation, the inclusion of cookies was conducted (Schnell, Hill & Esser, 2004). Furthermore, comprehension problems – which can be clarified for example in an oral or telephone survey – could be largely ruled out, since the topic and its essential contents were explained at the beginning of the survey. On the other hand, this issue was also tackled by the circumstance that the previous identification of potential participants was individual performed by each PP according to the definition of the target group. Against this background, it can be assumed that the participants in the survey are familiar with the topic. This was also reflected by the received results of two control questions, where the majority of the participants of the conducted online survey indicated that they 'use testing services to test their production' and that they have 'awareness of testing

[5] PP8 was also responsible for the acquisition of participants in the case of the German version of the online survey.

services in their own region'. This was crucial in order to generate profound results in the frame of examination of gaps in testing services in the BSR (Döring & Bortz, 2016).[6]

Deeply rooted in the fact that some PPs faced challenges during the acquisition of a sufficient response rate in a later stage of the data collection, and furthermore driven through the pressure of time triggered by an efficient progress of the overall project, some companies were contacted via telephone, during face-to-face meetings, training events or conferences, in order to reach a surplus or minimum response rate. In most of these cases, the potential participants were informed about the launched online survey and kindly asked to participate, as well as referred to or provided with an invitation that included the link to the online survey. Nevertheless, in some limited cases, the participants were directly asked to fill-in the questionnaire, which was provided in form of a physical printed version of the online survey. In order to receive the overall survey data in an aggregated form, the results of these questionnaires were also added on the online survey platform. Undoubtable, through this kind of data collection – here: personal (oral) and telephone interviews – the advantages of a purely online-based survey are impaired. Yet, this procedure of data collection represented an exception. On the other hand, this approach enabled the possibility of clarification of potential emerging minor comprehension problems, and in addition secured in some participating countries the achievement of a minimum response rate, which was crucial for a later profound data analysis.

[6] In the frame of the control question one, where the participants were asked whether they use testing services in order to test their production, in the overall sample, 60.87% of the participants indicated that they use testing services for their products. In the course of the second control question, participants where asked, whether they have awareness of testing services in their region. In this context, 70.435% of the participants answered that they have knowledge about testing services, which are offered in their region. Further results that are related to these two control questions are presented in the sub-chapter 'sample description' of this report.

Accordingly, in general, the data collection process was anonymised, and no one else – with exception of the representatives of the EU-project TEST-4-SME – could see the answers or information that had been provided by the participants. Furthermore, the participants of the online survey were informed on the first page of the online survey about the topic, aim and purpose of the survey and the EU-project called TEST-4-SME, data processing, as well as instructed that – if they are willing to participate – the survey should be completed based on experience, knowledge as well as quantitative and qualitative data about their company. In addition, the participants had been informed that participation is voluntary and that a minimum of data about their company was collected in order to analyse the needs of different types of enterprises, as well as the option to skip questions of the online survey. Moreover, it was indicated that the provided data was always treated confidentially and for further purposes aggregated anonymously in order to make the data usable for research and scientific purposes only. In sum, these given information on the introduction page of the online survey resulted in the option for the participant to agree on the indicated consent form and provided information, or not. All these information and the declaration of consent were implemented in order to be in line and to show compliance with the current EU data protection legislation.

2.2 Data analysis

After successful data collection phase, seamlessly, data analysis measures were performed. The empirical data analysis activities were finished by the end of March 2019[7]. The data analysis procedure embraced a two-step approach – data analysis on country level and afterwards on entire BSR level.

[7] In some cases, the data analysis procedure was already started at the beginning of January 2019, since some responsible PPs had already acquired a sufficient sample size in their specific country/region by the end of the year 2018.

Firstly, PP8 developed a template for a structured data analysis on country basis. Accordingly, PP8 forwarded the individual country-specific and relevant collected empirical data sets from the online survey platform 'Unipark', where the five language versions of the online survey had been implemented and conducted, as well as the structured data analysis template to one previously selected representative PP per country. By following the received instructions through the structured data analysis template and the empirical data set, each selected representative PP performed the data analysis for his home or responsible country.[8] These regional or country-based data analysis activities were finished by the latest on the 4th of March 2019, which resulted in transmits of these results to the overall responsible task leader (PP8). Afterwards, PP8 performed on the basis of these five country specific data analysis results a holistic data analysis about the entire BSR, which referred to the participating countries Estonia, Latvia, Lithuania, Finland and Germany.

Instruments that had been used in the frame of the data analysis embrace qualitative content analysis – especially in case of answers that were given by the participants in case of open questions – as well as statistical analysis. The latter case comprise descriptive and multivariate statistical data analysis on the basis of the received qualitative and quantitative data that were mainly gathered through given answers in the frame of closed-ended questions. In the course of descriptive statistical analysis, next to absolute and relative frequencies as well as frequency tables and graphs, the location parameter arithmetic mean and for control or comparison purposes in the case of the existence of dispersion also the median was used, and if appropriate the mode. In order to be able to carry out in case of conspicuousness – regarding the results of the mean in comparison to the median – a more profound assessment of the results on a case-by-case basis, a dispersion parameter – namely standard deviation – had

[8] PP8 was also responsible for the data analysis on national level in the case of the received German data set of the online survey.

been calculated, too. Accordingly, the assessment of the results was focused primarily to the determination of the results of the arithmetic mean. The median and the standard deviation were used in the course of the subsequent assessment of the results only if the arithmetic mean was in the conspicuous ("bad") range or if there were significant deviations from the median, which indicated an increased dispersion of the domains.[9]

In addition, multivariate statistical analysis was conducted, in order to receive even more profound results. In the frame of the multivariate statistical analysis, the ANOVA was performed in order to determine whether there exist differences in the individual samples, and through this, whether there exist differences in testing service supply in the determined countries, which allows to discover gaps in testing services within the BSR.[10] Therefore, also test of significance had been conducted.

[9] In this context, it should be pointed out that from the theoretical statistical point of view, due to the scale level of the attributes, which corresponds on the highest level to an ordinal scale, the calculation of the arithmetic mean and the standard deviation is normally not allowed, because both parameters require at least a metric scaling of the attributes. In the context described here, however, an average calculation based on the arithmetic mean (and therefore also the standard deviation, since it measures the deviation of the domains from the arithmetic mean, determined via the quadratic deviation of the domains from the mean through the variance) is customary in practice (e.g. grade point average calculation at school, university, etc.) as well as research landscape. In addition, the information content of the arithmetic mean is greater, compared to the median. This is, because the arithmetic mean measures the distances between the individual domains, whereas the median only indicates the middle of the distribution. Vice versa this also reflects the decisive disadvantage of the arithmetic mean (including the standard deviation), in the course of the calculation within the framework of a present ordinal scale, since the distances between the individual domains are normally not measurable and interpretable due to the coding.

[10] Similarly, in the case of the ANOVA, from a purely theoretical statistical point of view, again at least one variable must exhibit a metric scale level. Nevertheless, the calculation is also based on arithmetic means and quadratic deviations. Therefore, the same reasons – as mentioned before in the frame of the calculation requirements in the case of the mean and standard derivation – can be highlighted here.

On the basis of these statistical analysis (incl. arithmetic mean, median, etc.) the gap analysis is performed through the usage of the “two-component approach” in order to measure the customer satisfaction, which can be used as a guideline for the identification of service gaps (Prause, 2003). In the case of customer satisfaction measurements, two approaches are usually pursued simultaneously in the corresponding surveys, asking for importance as well as perceived satisfaction. Thus, in addition to researching the current satisfaction or dissatisfaction of the customers with the service used, the customer's claims will be simultaneously determined, i.e. also the expectations that the customer wishes in advance of the utilisation of the performance. For example, in a two-component approach, a questionnaire on customer satisfaction always reveals two questions, one on the importance and one on the current satisfaction of the customer.

This two-component approach allows to interpret the importance as a target value/figure, i.e. as the set point, while the current satisfaction can be understood as the actual value from the customer perspective. From the difference between the values of importance and satisfaction in the answers of the customers, it becomes possible to gain valuable information on the need for action. For instance, if the survey carries out that the customer considers a certain service to be more important than currently realised, there is an acute need for action to increase the present customer satisfaction. The corresponding action portfolio, which builds upon the comparison between importance and satisfaction, with the most important action instructions, can be represented graphically in the form of a customer satisfaction matrix, which is shown in Figure 1 below.

Accordingly, for reasons of customary application in practice as well as in the research landscape in similar situations, the ANOVA can be applied in the course of this present data analysis on the basis of the given data basis with its specific features.

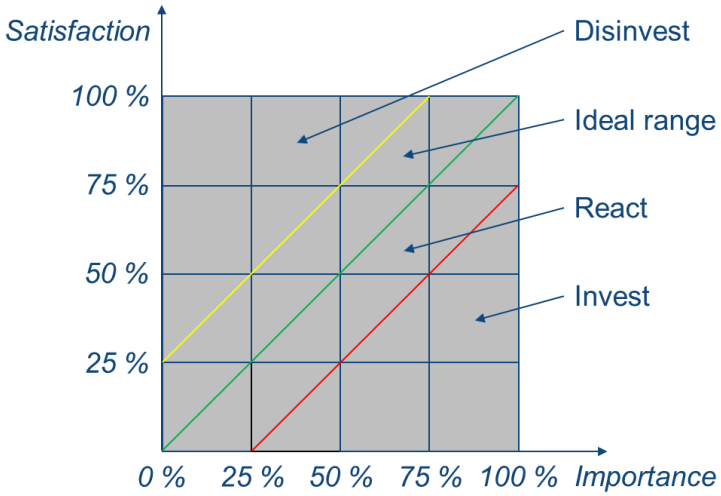

Figure 1. Customer satisfaction matrix.

Source. Authors' illustration, based on Prause (2003).

The ideal range in the relationship between the established satisfaction and the desired importance represents the state in which satisfaction and importance are almost in balance. If the satisfaction exceeds the importance then there is a risk that the relatively high satisfaction scores were achieved with too high investment costs, which is often associated with satisfaction deficits in other important services, so that a possible disinvestment is indicated. Finally, if satisfaction is too low in comparison with importance, there is a need for rapid action to strengthen this service, i.e. an investment is recommended. In order to describe the relationship between satisfaction and importance, in practice the customer satisfaction index is often used as a characteristic parameter (ibid):

$$CSI = 100 * \frac{S}{I} \quad in\ \%, if\ I > 0.$$

where

CSI Customer Satisfaction index;

S Satisfaction;

I Importance.

This measure (CSI) represents the ratio of perceived customer satisfaction to the perceived importance of an offered service. If the examined services are plotted and the current satisfaction values with their expected importance are compared, i.e. if a target-actual comparison on the basis of the results of the customer satisfaction analysis is carried out, it is possible to gain a characteristic assessment profile from customer's perspective in form of a strength-weakness analysis, which is well-known from the controlling (especially: target costing).

2.3 Sample description

During the data collection phase, 571 companies accessed the online survey via the link to the website. Thereby, 571 represents only the number of companies that have accessed the online survey, even more had been contacted. The total number of contacted and invited participants was not comprehensible any more at the end of the data collection phase. This is also deeply rooted in the fact that some potential participants had been invited to participate in the online survey during training events or conferences, where the number of participants was unmanageable and hardly

calculable. However, a total of 115 companies have fully participated in the underlying survey. Accordingly, this represents a dropout rate of 79.860%.[11] The population is made up of companies that produce electronic products and are located in the eligible catchment area of the Baltic Sea Region Programme (2014 – 2020), which is further limited in the frame of the performed data collection (online survey) to the inclusion of the five eligible regions/countries: Estonia, Latvia, Lithuania, Finland and Germany. The description of the underlying sample is given in Table 1.

According to Table 1, the sample size of total 115 companies consist of 44 companies from Estonia, 15 companies from Latvia, 14 companies from Lithuania, 22 companies from Finland and 20 companies from Germany. The biggest proportion of companies are small and medium sized companies and Mirco firms, which represent together 89.565% (SMEs 56.522% and Mirco companies 33.043%) in the overall sample. This is also visible according to the different partial samples, whereby only in the partial sample that belongs to Lithuania, the amount of micro and SMEs is equal (both seven participants), and in the case of the German partial sample, the number of Mirco firms is slightly higher compared to SMEs (micro firms eight and SMEs seven participants). Furthermore, in the partial samples of Latvia and Lithuania, no large companies participated in the course of the online survey, whereby the proportion of large companies in the German partial sample was the highest with 25% among all partial samples. Considering the defined main target group – namely SMEs – it can be concluded that this target group was reached through the conducted online survey and is represented through the sample.

[11] The dropout rate in case of the introduction page of the survey is equal to 66.375% (h_i = 379). The main reason for this dropout rate might be traced back to the circumstance that on the introduction page, the potential participants had been informed that a minimum of data about their company would be collected in the frame of the online survey in order to analyse the needs of different types of enterprises, which could have had a deterrent effect.

Furthermore, the sample consist mainly of older companies, because 60% of all participating firms indicated that their company was founded more than ten years ago. The proportion of younger companies that are not older than 5 years represents nearly one quarter (22.609%). This circumstance can be traced back to the partial samples of Estonia, Lithuania, Finland and Germany, where the proportion of older companies predominate (EE = 59.091%, LT = 42.857%, FI = 86.364%, DE = 70%). One exception in this context is the Latvian partial sample, where the proportion of older companies is relatively low (26.667%) and the proportion of companies with an age between more than two years and a maximum of five years is relatively high (46.667%), compared with the other partial samples (EE = 13.636%, LT = 14.286%, FI = 4.545%, DE = 10%). In contrast to this, it can be stated that no start-ups, which are more or less represented by participating companies with an age of equal or less than two years, are recorded in the partial samples of Latvia and Finland, whereby the proportion of start-ups in the Lithuanian and German partial sample is relatively high (LT = 14.286%, DE = 15%) in comparison with the other partial samples (EE = 6.818%, LV =0%, FI = 0%). By comparing the age and the size of the companies in the sample, it can be stated that especially in the case of the Latvian and Estonian partial samples, the results are a little bit surprising, since Mirco firms are often associated with start-ups to a certain degree. This is deeply rooted in the fact that start-ups are regularly mainly young companies in an early development stage according to the company life circle, and therefore, often exhibit a small company size in defined terms of turnover, number of employees as well as balance sheet total. According to Table 1, it can be stated that the seven micro firms of the Latvian partial sample do not really represent start-ups. However, also in the case of the other partial samples, it should be noted that there seems to be no strong correlation between the micro firms and start-ups.

Table 1: Sample description

	BSR		Estonia		Latvia		Lithuania		Finland		Germany	
	hi	**fi (in %)**	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)
Number / proportion of participants	**115**	**100,000**	44	100,000	15	100,000	14	100,000	22	100,000	20	100,000
Company size												
Micro	**38**	**33,043**	15	34,091	7	46,667	7	50,000	1	4,545	8	40,000
Small or Medium	**65**	**56,522**	23	52,273	8	53,333	7	50,000	20	90,909	7	35,000
Large	**12**	**10,435**	6	13,636	0	0,000	0	0,000	1	4,545	5	25,000
Company age												
x ≤ 2 year	**8**	**6,957**	3	6,818	0	0,000	2	14,286	0	0,000	3	15,000
2 < x ≥ 5 years	**18**	**15,652**	6	13,636	7	46,667	2	14,286	1	4,545	2	10,000
5 < x ≥ 10 years	**20**	**17,391**	9	20,455	4	26,667	4	28,571	2	9,091	1	5,000
x > 10 years	**69**	**60,000**	26	59,091	4	26,667	6	42,857	19	86,364	14	70,000
Geographic scope of business												
Local	**24**	**20,870**	15	34,091	2	13,333	2	14,286	0	0,000	5	25,000
National	**19**	**16,522**	5	11,364	3	20,000	2	14,286	2	9,091	7	35,000
International	**72**	**62,609**	24	54,545	10	66,667	10	71,429	20	90,909	8	40,000
Business activity fields (multiple answer options)												
Electronic devices	**77**	**39,286**	29	38,158	13	54,167	9	40,909	14	48,276	12	26,667
Materials for electronical devices	**13**	**6,633**	6	7,895	1	4,167	2	9,091	0	0,000	4	8,889
Materials for protection from electromagnetic field	**8**	**4,082**	1	1,316	2	8,333	0	0,000	0	0,000	5	11,111
Parts, components and/or pieces for electrical devices	**31**	**15,816**	12	15,789	4	16,667	4	18,182	4	13,793	7	15,556
Computing, ICT technologies, R&D	**29**	**14,796**	14	18,421	2	8,333	1	4,545	3	10,345	9	20,000
Other	**38**	**19,388**	14	18,421	2	8,333	6	27,273	8	27,586	8	17,778
Total	***196***	***100,000***	*76*	*100,000*	*24*	*100,000*	*22*	*100,000*	*29*	*100,000*	*45*	*100,000*

Source. Authors' illustration and compilation

By analysing the geographical scope of business, the biggest proportion of the companies (62.609%) indicated that they are active on international markets. As mentioned before, this indirectly also implies that the majority of the companies in the total sample have to fulfil conformity to international product standards. Accordingly, it can be stated that especially for these companies, testing services are of high priority, otherwise the export of their electronic products will fail on international markets and their internationalisation efforts are ineffectual. In comparison to all partial samples, it can be confirmed that international markets have the greatest importance for electronic producing companies (EE = 54.545%, LV = 66.667%, LT = 71.429%, FI = 90.909%, DE = 40%). In the case of the German partial sample it is visible that also the local and national market play a significant role for the business of the participating companies (local = 25%, national = 35%). This might be reasoned in the size of the country and the strong electronic industry or consumption rate of electronic products in Germany, in comparison for example to the three Baltic States. Furthermore, micro and SMEs, like in the German partial sample (together 75%), often act as suppliers for bigger manufacturers, which might be in the case of Germany a reason of proximity (to bigger manufacturers) and as a result thereof the relevance of the local and national market in the German partial sample. A peculiarity from this is clearly evident in the case of the Estonian partial sample, since the relevance of the local market is indicated here with a proportion of 34.091%. This might be reasoned through the comparison with the size of Estonia companies that participated in the online survey. Also 34.091% in the Estonian partial sample are Mirco firms and these kind of firms often do not have the capacities or capabilities in order to be competitive on international markets, due to their size. Therefore, micro companies often focus on local and national markets, in comparison to SMEs and especially large companies. In contrast to this, this applies also vice versa for Finish companies, who participated in the survey. In the Finish partial sample, the local market has a subordinate role (0%), whereby the relevance of the international markets for companies' business was the highest (90.909%) by a clear margin among all partial samples (EE = 54.545%, LV = 66.667%, LT = 71.429%,

DE = 40%). This can be reasoned again by the proportion of Finish micro firms, who participated in the survey, which was extremely small (4.545%), compared with the other partial samples (EE = 34.091%, LV = 46.667%, LT = 50%, DE = 40%). Some correlations between the age of the companies and the scope of their business seem to be obvious in particular in the two partial samples of Lithuania and Finland. In general, younger companies that are quite new or are in an early company development stage tend to gain a foothold firstly on local and national markets, before they start to grow and try to expand their business on international markets. Accordingly, for young electronic products producing companies conformity to international product standards plays a crucial role, if they want to reach over time the growth phase and expand their business on international markets.

In addition, in the course of the geographical scope of business, the participants were further asked on which international markets they are active, if international markets are of relevance. The results thereof were summarised through a conducted content analysis. Thereby the indicated different international country specific markets were aggregated to continental markets, in order to receive an overview about the most important international markets of electronic producing companies from the BSR. In the Table 2, the results thereof were structured by country affiliation or origin of participants, respectively, in comparison to continental markets of business relevance. A detailed exploitation of the individual answers (business activities in country specific international markets) of the anonymised participants is attached to the Appendix C of this report.

According to Table 2, the most important international markets for electronic producing companies from the BSR are in Europe (37.5%), which are followed by international markets in North America (20.455%) and Asia (17.045%). Other international markets in Africa, Australia and South America play a subordinate role for the export of electronic products. Against this, 22.727% of the participants indicated that their company is worldwide active. By comparing these results and findings with the different

individual partial samples, it can be stated that the five partial samples are quite homogenous and therefore support these conclusions mentioned before. Only minor peculiarities are obvious. For instance, in the partial sample of Germany, no participant indicated that the markets in North America are of interest for their company, neglecting the fact that 50% of the German participating companies declared that their company is worldwide active. Therefore, another conspicuousness can be seen in the fact that in the partial samples of Finland and Germany, the proportion of companies that are worldwide active is relatively high (FI = 41.176%, DE = 50%), compared with the other partial samples (EE = 11.429%, LV = 14.286%, LT = 21.429%).

By analysing the business activity fields (cf. Table 1), it is obvious that the majority of companies engage in ‘electronic devices’ (39.286%), followed by ‘parts, components and/or pieces for electrical devices’ (15.816%) and ‘computing, ICT technologies, R&D’ (14.798%). Again, by comparing these results and findings with the different individual partial samples, it can be stated that the five partial samples are quite homogenous and therefore support these conclusions mentioned before. Accordingly, the predomination of the production of ‘electronic devices’ is also visible among all partial samples (EE = 38.158%, LV = 54.167%, LT = 40.909%, FI = 48.276%. DE = 26.667%). Also the engagement in ‘parts, components and/or pieces for electrical devices’ as well as ‘computing, ICT technologies, R&D’ rank on the second or third place among the partial samples. Only in the case of the Lithuania partial sample a minor non-conformance can be found, since the proportion of companies that are active in the field of ‘computing, ICT technologies, R&D’ is relatively small (4.545%), compared with the other partial samples (EE = 18.421%, LV = 8.333%, FI = 10.345%, DE = 20%), whereby the proportion of companies that produce ‘materials for electronical devices’ is relatively high (9.091%), compared with the other partial samples (EE = 7.895%, LV = 4.167%, FI = 0%. DE = 8.889%), and thus, ranks on the third place in the respective partial sample (Lithuania). Further peculiarities can be seen in the circumstance that the distribution in the German partial sample is a little bit more balanced, in comparison with the other partial samples. In addition, it is obvious

that the activity field ‘materials for protection from electromagnetic field’ is unrepresented, which is especially true for the Lithuanian and Finish partial samples, since no related company indicated to engage in this kind of materials. Furthermore, also in the case of the production of ‘materials for electronical devices’ in the Finish partial sample, no company is listed. Lastly, it should be note that in the overall sample 19.388% of the participants used the answer option ‘other’. Through this, the participants were further asked to indicate their specific business activity field(s). Due to the high diversification of the given answers, the conduction of a content analysis made less sense. Accordingly, an overview about the business activity field(s) that were not covered by the predefined answer options, which were mentioned by the participants in the frame of the answer option ‘other’, are anonymised listed in Appendix D of this report.

As mentioned in the previous sub-chapter ‘data collection’, two control questions were implemented in the online survey in order to figure out, whether the participants have profound knowledge about the relevant examination topic. This was crucial in order to ensure validity of the generated results in the frame of investigation of gaps in testing services in the BSR (Döring & Bortz, 2016). The detailed results of these control questions are summarised in Table 3. In the frame of the control question one, where the participants were asked whether they use testing services in order to test their production, in the overall sample, 60.87% of the participants indicated that they use testing services for their products. A bigger proportion would be desirable, but at least it can be concluded that the majority of the companies, who participated in the online survey, demand testing services and thus have experience about testing services. Also in the individual partial samples, it is obvious that the majority of participants use testing services to test the own production (EE = 54.545%, LV = 60%, LT = 71.429%, FI = 90.909%). Only the German partial sample exhibit an exception, since only 35% of the German participants declared that they use the offered testing services on the market. Due to the fact that the reasons for the results in the German partial sample are hardly traceable, it is assumed that some outliers occurred in the frame of this question.

Table 2: Geographical scope of business – international

	BSR		Estonia		Latvia		Lithuania		Finland		Germany	
International business	**hi**	**fi**	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)
Africa	**2**	**2,273**	0	0,000	1	7,143	1	7,143	0	0,000	0	0,000
Australia	**0**	**0,000**	0	0,000	0	0,000	0	0,000	0	0,000	0	0,000
Asia	**15**	**17,045**	7	20,000	3	21,429	2	14,286	2	11,765	1	12,500
Europe	**33**	**37,500**	15	42,857	5	35,714	5	35,714	5	29,412	3	37,500
North America	**18**	**20,455**	9	25,714	3	21,429	3	21,429	3	17,647	0	0,000
South America	**0**	**0,000**	0	0,000	0	0,000	0	0,000	0	0,000	0	0,000
Worldwide	**20**	**22,727**	4	11,429	2	14,286	3	21,429	7	41,176	4	50,000
Total	***88***	***100,000***	*35*	*100,000*	*14*	*100,000*	*14*	*100,000*	*17*	*100,000*	*8*	*100,000*

Source. Authors' illustration and compilation

Table 3: Control questions

	BSR		Estonia		Latvia		Lithuania		Finland		Germany	
	hi	**fi (in %)**	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)
Number / proportion of participants	**115**	**100,000**	44	100,000	15	100,000	14	100,000	22	100,000	20	100,000
Usage of testing services for production												
No	**45**	**39,130**	20	45,455	6	40,000	4	28,571	2	9,091	13	65,000
Yes	**70**	**60,870**	24	54,545	9	60,000	10	71,429	20	90,909	7	35,000
Awareness of testing services in own region												
No	**34**	**29,565**	9	20,455	6	40,000	5	35,714	4	18,182	10	50,000
Yes	**81**	**70,435**	35	79,545	9	60,000	9	64,286	18	81,818	10	50,000

Source. Authors' illustration and compilation

Furthermore, if the participants chose the answer option ‘yes’, they were further asked for the indication of the relevant testing institutions, where they demand testing services. An overview about the institutions, where testing services are demanded by the participants is given in Appendix E of this report, which showcases the elaborated results of a conducted content analysis; the anonymised raw data, which functioned as an analysis ground base, is drawn in Appendix F of this report. Deeply rooted in the fact that the participants were acquired from and outside PPs’ networks (cf. sub-chapter ‘data collection’), the results thereof show that the majority of the participants use mainly offered testing services from the PPs of the EU-project TEST-4-SMEs (e.g. LV: LEITC (RTU), LT: Protech, FI: Centria). An exception from this represents ‘Inspecta’ (KIWA), which seems to be widely used as institution for product testing in Estonia (38.889%). A general trend of preferred testing institutions in the German partial sample was not detectable. On the other hand, offers of some testing institutions seem to be demanded in more than one BSR country, e.g. ‘Cetecom’ in Estonia and Latvia, ‘RISE’ (RI.SE) in Estonia and Finland, ‘LEITC’ (RTU) in Estonia and Latvia, ‘Inspecta’ in Estonia and Lithuania, ‘TÜV’ in Latvia and Lithuania, and ‘Dekra’ in Latvia and Germany. Especially in case of the three Baltic States and to a certain extend also including Finland, this might be reasoned through the geographical proximity of these counties to each other. Other explanations are that the mentioned testing institutions have good reputations, or, are active with many labs in different countries due to their strong market position.

In the course of the second control question, participants where asked, whether they have awareness of testing services in their region. According to Table 3, 70.435% of the participants answered that they have knowledge about testing services in their specific region. Hence, the result of the second control question is considerable better, compared with the first control question (60.87%). In general, it should be stated that for the purposes of the present gap analysis of testing services in the region, the positive feedback in the frame of the second control question is more important, in

comparison to the first control question; since, even if the companies, who participated in the online survey, do not demand testing services, at least, if they have knowledge and awareness about the offered testing services in their region, they are able to comment valuation to the specific situation about testing services in their region/country. By comparing the overall sample result with the different partial samples, it can be concluded that this result is also visible in the different partial samples (EE = 79.545%, LV = 60%, LT = 62.286%, FI = 81.818%). Again, only in the case of the German partial sample, the proportions are equal (50%). Nevertheless, by comparing this result of the German partial sample with the first control question (35%), it can be stated that the result has improved (50%).

Also in the frame of the second control question, if the participants chose the answer option ‘yes’, they were further asked for the indication of the relevant testing institutions in their region. An overview about the institutions that are known by the participants in their region is given in Appendix G of this report, which highlights the elaborated results of a conducted content analysis; the anonymised raw data, which functioned as an analysis ground base, is summarised in Appendix H of this report. Similarly, as mentioned in the frame of the first control question, deeply rooted in the fact that the participants were acquired from and outside PPs’ networks (cf. sub-chapter ‘data collection’), the results thereof show that the majority of the participants mainly know testing institutions in their region that are PPs of the EU-project TEST-4-SMEs (e.g. LV: LEITC (RTU), LT: Protech, FI: Centria, DE: University of Wismar). In the case of the Estonian partial sample the most often mentioned testing institution that is known by the participants in their region was ‘TalTech’ (TUT) with 25%, followed by ‘Inspecta’ (KIWA) with 21.875% and Tartu Obs. with 15.625%. Furthermore, only ‘LEITC’ was mentioned as a testing institution, which is known in the respective region of participants, who came from different countries, namely Estonia and Latvia. Since ‘LEITC’ belongs to the Riga Technical University (PP3), who has his single location in Riga, it might be argued that the previously mentioned finding, can be traced back to

the fact that ‘LEITC’ seems to have a good reputation with a good offer and/or profits from its location, which might be seen as a factor of success.

3. Results

3.1 Identification and analysis of gaps in testing services

In order to identify gaps of testing services, the participants had been asked to give their opinion according to the ‘level of availability of testing infrastructure’ and ‘level of accessibility of testing services’ in their region. The number of testing services in both fields was equal and embraced 14 different kinds of testing services. The assessment scale corresponded to a five-item scale. This coded item-scale consisted of (1) complete shortage / very low accessibility, (2) poor availability / low accessibility, (3) adequate availability / accessibility, (4) good availability / accessibility, and (5) very good availability / accessibility. Furthermore, in order to avoid distortions in the answers, an alternative answer option has additionally been added, which gave the participants the possibility to indicate that they are "not interested in this type of testing service".

For the analysis of interest or no interest in testing services, the location parameter mode was used. By analysing the relative frequencies of the response behaviour in case of no interest, it is possible at the same time to make conclusions about the testing services with the highest interest. The graphical analysis of the elaborated results is showcased in Figure 2 and 3. In this context, it needs to be mentioned that the participants were ask two times in the online survey whether they have interest in specific testing services (‘level of availability of testing infrastructure’ and ‘level of accessibility of testing services’ in own region), but the content background in case of no interest for specific testing services in the frame of both questions is nearly the same. This was also confirmed by a comparison of the received results of both questions that refer to no interest for specific testing services. Therefore, the absolute frequencies that had been derived from both questions had been accumulated, and on

the basis of this, the relative frequencies had been calculated for further analysis purposes. Accordingly, Figure 2 and 3 exhibit the aggregated results.

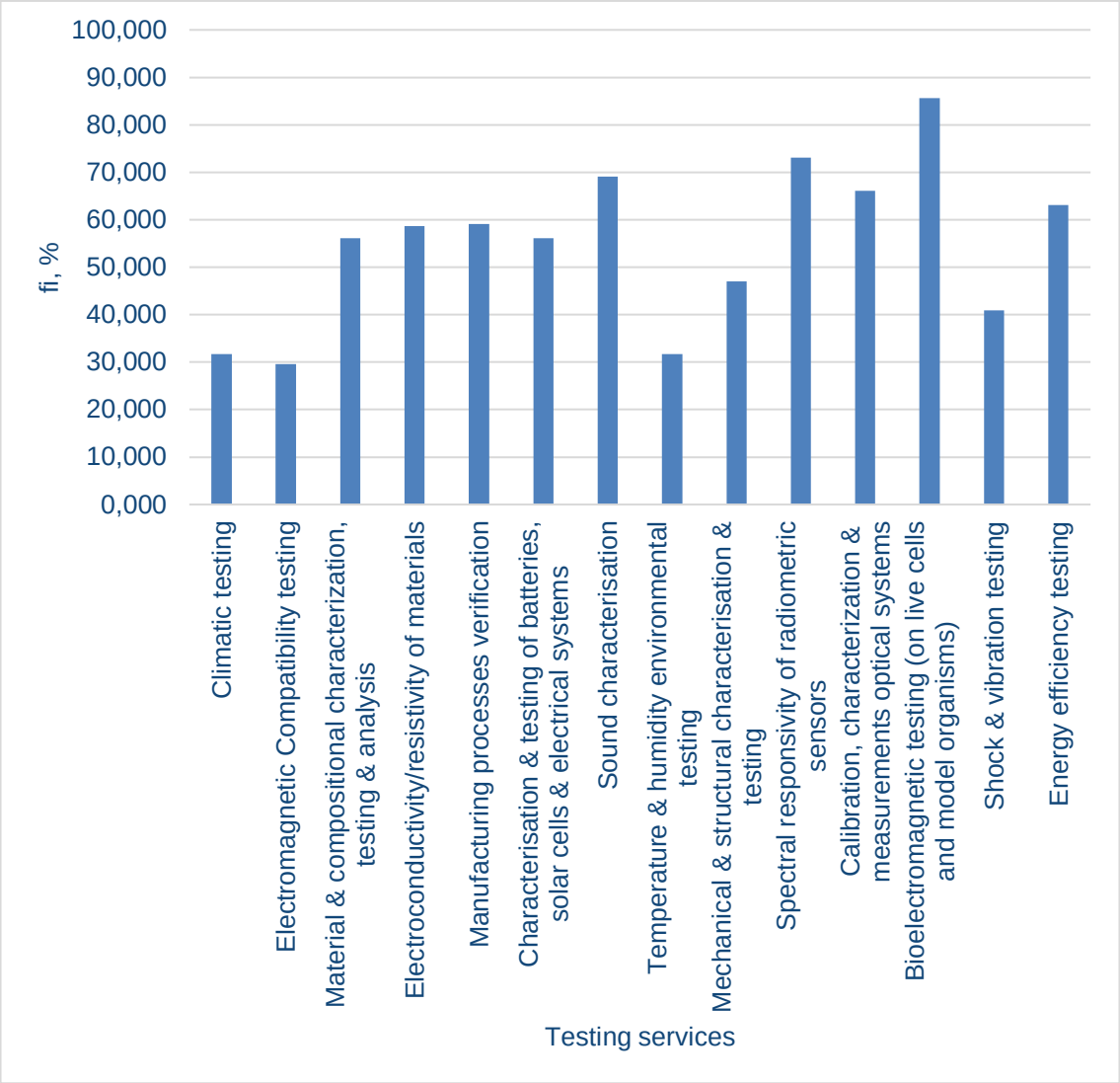

Figure 2. No interest in testing services – BSR.

Source. Authors' illustration and compilation

By analysing Figure 2, it can be derived that on entire BSR level, for the testing service 'bio-electromagnetic testing (on live cells and model organisms)' the lowest interest (85.652%) is apparent. Vice versa the highest interest for testing services in the BSR can be identified in the frame of 'electromagnetic compatibility testing', 'temperature &

humidity environmental testing' and 'climatic testing', since the proportion of companies, who indicated that they have no interest in this type of testing represent in the same order only 29.565%, 31.739% and 31.739%. As exhibited in Figure 3, similarities apply for Estonian companies, since the lowest interests with 92.045% and 81.818% are observable for 'bio-electromagnetic testing (on live cells and model organisms)' and 'spectral responsivity of radiometric sensors', as well as the highest interest in case of 'electromagnetic compatibility testing' (29.545%), 'temperature & humidity environmental testing' (25%) and 'climatic testing' (26.136%). In the case of Latvia, the lowest interest is noticeable for 'sound characterization' (90%), 'spectral responsivity of radiometric sensors' (90%), 'bio-electromagnetic testing (on live cells and model organisms)' (86.667%) and 'calibration, characterization & measurements optical systems' (80%), whereby the highest interest exist for 'electromagnetic compatibility testing' (26.667%).

In Lithuania, the lowest interest for testing services is identifiable for 'bio-electromagnetic testing (on live cells and model organisms)' (89.286%) and 'sound characterization' (85.714%), and the highest interest for 'characterization & testing of batteries, solar cells & electrical systems', whereby in the latter case a relative frequency of 39.286% is relatively high compared with the other testing services with highest interest in the previously mentioned partial samples Estonia and Latvia (cf. Figure 3). In the case of Finland, the greatest volatilities can be observed in Figure 3, since the number of testing services with low interests is quite high as well as the number of testing services with high interest, as well as the respective individual results of relative frequencies. For instance, no Finish company in the partial sample is interested in 'bio-electromagnetic testing (on live cells and model organisms)', which is equal to a proportion of 100%. Next to this, of low interest are also the services 'characterization & testing of batteries, solar cells & electrical systems' (93.182%), 'energy efficiency testing' (90.909%), 'spectral responsivity of radiometric sensors' (86.364%), 'calibration, characterization & measurements optical systems' (84.091%) and 'manufacturing processes verification' (81.818%). On the other hand, in the Finish

sample, the highest interest is detectable for ‘climatic testing’ (20.455%), ‘temperature & humidity environmental testing’ (25%) and ‘electromagnetic compatibility testing’ (29.545%), whereby a relative frequency of 20.455% in the case of ‘climate testing’ is relatively low, compared with other previous mentioned testing services with high interest in the different partial samples of Estonia, Latvia and Lithuania.

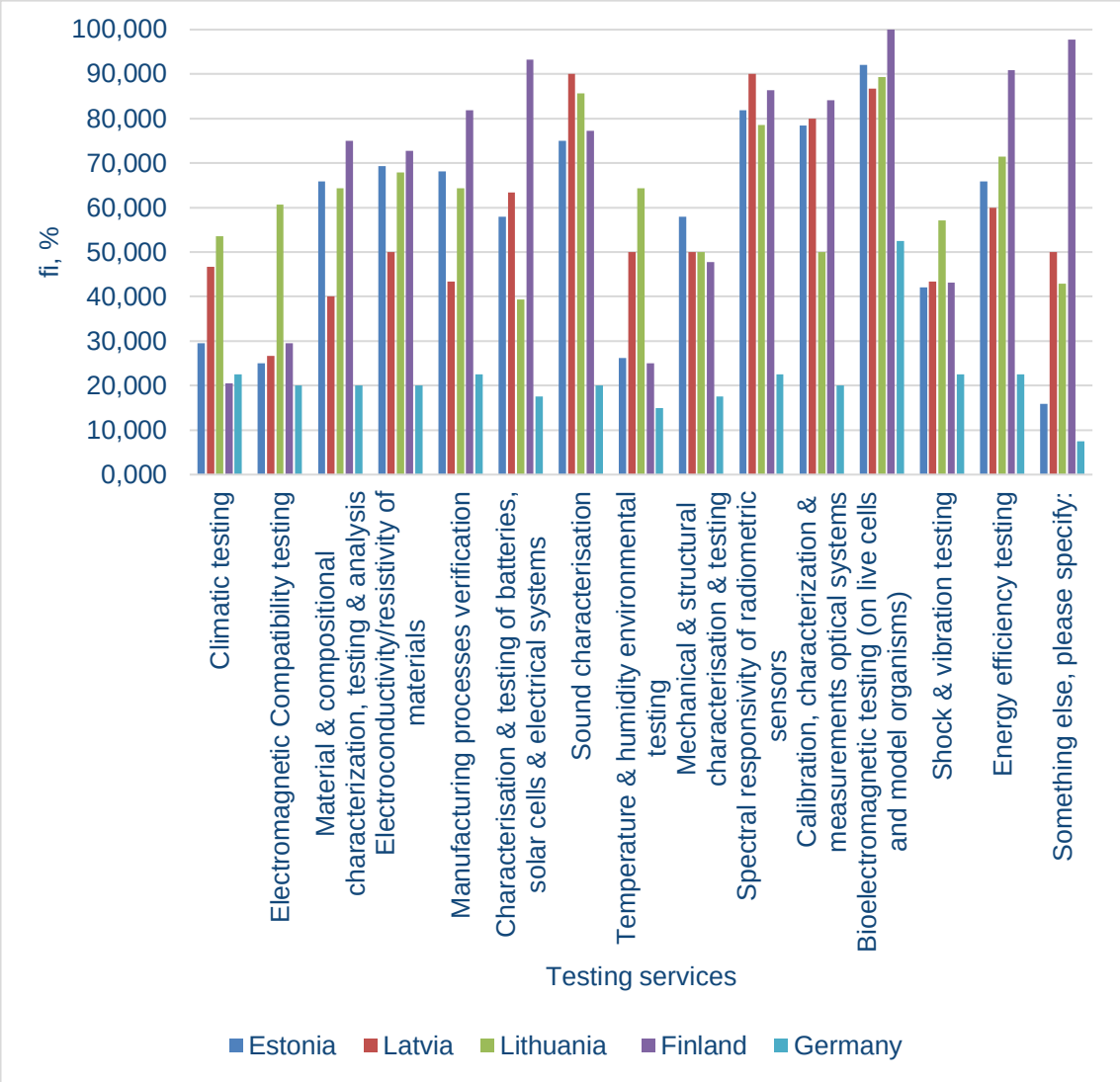

Figure 3. No interest in testing services – national level.

Source. Authors’ illustration and compilation

The German partial sample can be regarded as the complement to the Finish sample in the frame of indicated interests in testing services (cf. Figure 3). Furthermore, it can be also argued that the results of the partial sample of Germany, in this context, represent a distortion, if the response behavior is compared with all other four partial samples. On the one hand, this is also deeply rooted in the fact that the testing service with the lowest interest is 'bio-electromagnetic testing (on live cells and model organisms)' with 52.5% as relative frequency. The fact that in Germany, the testing service 'bio-electromagnetic testing (on live cells and model organisms)' exhibits the lowest interest for companies corresponds to all other four partial samples, but the proportion of 52.5% with no interest in this testing service is extremely low, compared with the results in all other four partial samples. On the other hand, for all other 13 testing services, in the German sample, the interest is quite high, since the relative frequency of no interest for all other 13 testing services range only from 15% to 22.5%. One reason for the generally high interest in testing services of German companies in the sample could be seen in the possibility that the product portfolio of these companies embrace many different product types and thus, must fulfill many different types of certification requirements. Another reason could be that the compliance policies or directives, respectively, for product certification in order to put products on the domestic market are quite extensive in Germany. Both assumptions can be partly or fully supported by the circumstance that according to Table 1, in the German partial sample, 60% are SMEs or large companies, 70% are older than 10 years and 60% focus on local and national markets.

In the frame of the evaluation of the 'level of availability of testing infrastructure' and 'level of accessibility of testing services' in their region, the participating companies had been further asked if some testing services of interest exist, which had been not covered through the 14 different testing services that were given. The number of answers to this were quite small, which confirms the validity of given answer options and the success of the conducted two-step pre-test approach. The given answers are

listed below with the addition information of national affiliation, which is indicated through the country code:

- Sonoacoustic analysis (EE),
- Residual gas analysis (LV),
- Solar and salt test (LV),
- Active and reactive energy measurements according to the MID directive (LV),
- Metrological verification of measuring instruments (LT),
- Solar power tests on site (LT),
- Laser equipment safety class characterization and testing (LT), and
- Nano-technological tests (DE).

In order to detect gaps of testing services in the region, as a first step, the ANOVA was performed, in order to analyse whether their exist significant differences between the five countries / regions in relation to the evaluation behaviour in case of the individual testing services. By doing so, significant differences between the partial samples could be identified in the frame of the testing service ‘characterization & testing of batteries, solar cells & electrical systems’ with p-value of 0.00049 (‘level of availability of testing infrastructure’) and 0.00901 (‘level of accessibility of testing services’). Furthermore, a nearly significant difference could be observed in the course of the testing service ‘material & compositional characterization, testing & analysis’ with a p-value of 0.05868 (‘level of availability of testing infrastructure’) and 0.09363 (‘level of accessibility of testing services’). It should be also noted, that in the case of ‘shock & vibration testing’ a p-value of 0.10727 (‘level of availability of testing infrastructure’) and in the frame of ‘calibration, characterization & measurements optical systems’ a p-value of 0.13522 (‘level of accessibility of testing services’) were gained, which show a slightly tendency towards significance – depending on where the level of significance is drawn. Therefore, in principle, it could be determined from the ANOVA that there exist significant differences in the partial samples and thus, there exist gaps of testing services in the region. However, the results based on the ANOVA were not as clear as

expected. Since the ANOVA cannot show where or in which country the gaps in testing services have occurred, a more in-depth analysis of customer satisfaction using the two-component approach is presented in the following.

Accordingly, deeply rooted in the fact that the online survey followed the two-component approach, at the same time both, the importance and the current perception were asked in the online survey for the same portfolio of testing services; and thus, the resulting target values and actual values represent the assessment of these respective 14 testing services. To be more precise, from the perspective of testing service customers, the ‘accessibility of testing services’ correspond to the satisfaction of the supply and therefore represent the actual values for the individual testing services. Vice versa, the ‘availability of testing infrastructure’ is the equivalent of the importance or demand / interest, and thus is regarded as the target values of the respective testing services. For all these gathered target and actual values the corresponding arithmetic mean, median and standard deviation had been calculated, which in each case referred to the five-item scale by neglecting the alternative answer option ”no interest”. In addition, the CSI values were determined for each of the 14 testing services, which were grounded on the arithmetic means of the target and actual values as input variables. The graphical illustration of these resulting CSI values, which refer to the entire BSR, is shown in Figure 4.

This illustration of the CSI values (cf. Figure 4) delivers indications for the need of action in the course of measures for the increase of customer satisfaction. From the action portfolio in the customer satisfaction matrix it can be immediately observed that there is an acute need for action in the frame of the testing service called ‘energy efficiency testing’ (CSI = 89.641%). On the other hand, in the course of ‘shock & vibration testing’ an extraordinary overage is indicated (CSI = 108.807%).

In order to draw a clearer picture of the current situation of the testing services, it is necessary to have a closer look on the individual performance on national level.

Through this, the identification of gaps of testing services in the region is more profound ensured. The respective results are showcased in Figure 5.

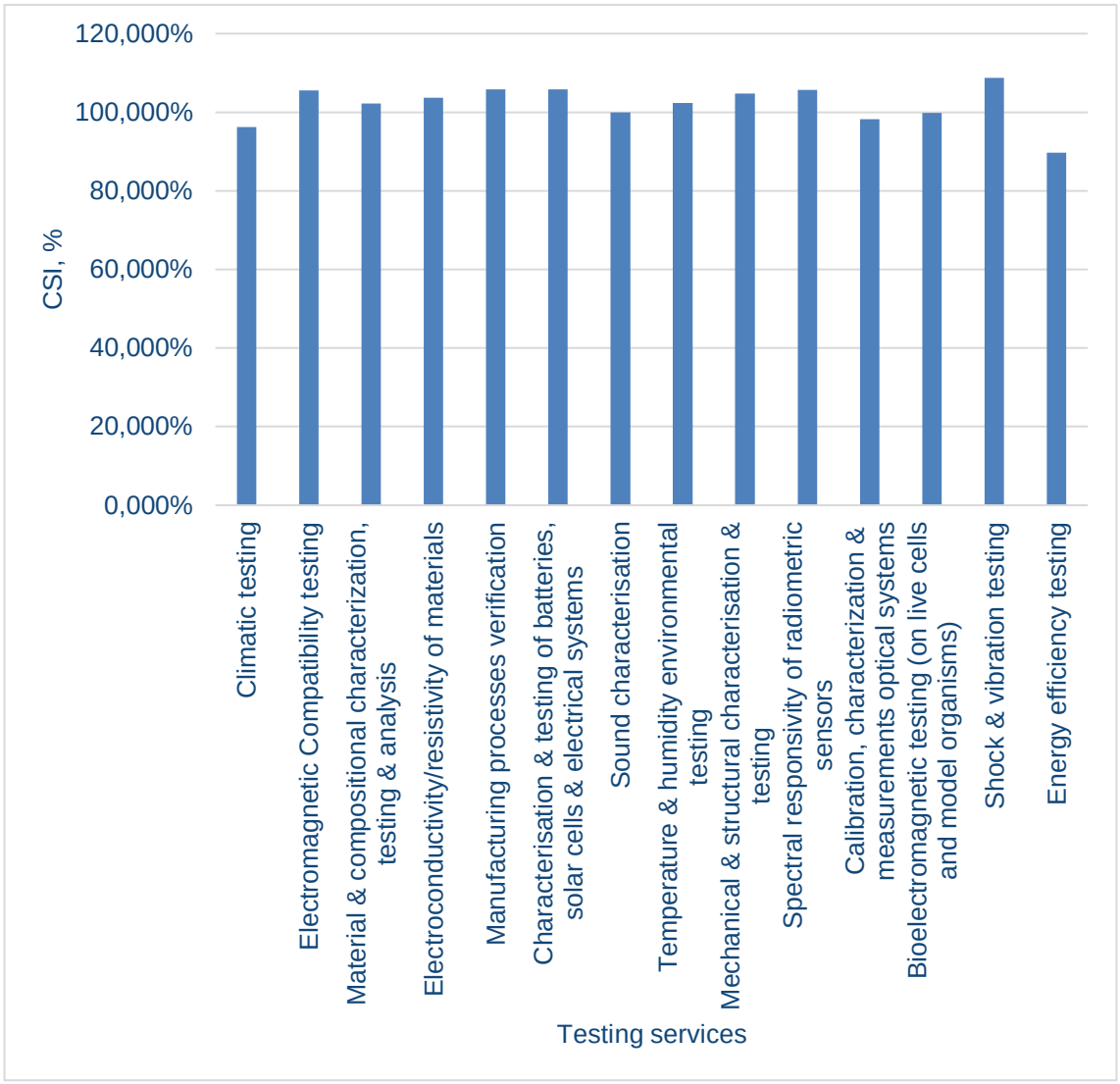

Figure 4. CSI – BSR.

Source. Authors' illustration and compilation

By analysing Figure 5, it can be stated that in the case of the testing service 'climate testing', there is an urgent need for action in Lithuania, since the CSI of 72% represents a too low satisfaction of customers in comparison to the assessed importance of this testing field. Similarities applies to Lithuania in the course of 'material & compositional

characterization, testing & analysis', since the CSI of 68.421% represents again a too low satisfaction in comparison to the evaluated importance of this testing service. On the other hand, for Finland, it can be stated that a CSI of 111.111% in this testing field is slightly too high, since the satisfaction can be evaluated as too high compared with the resulting importance, which points that the relatively high satisfaction score was achieved with too high investment costs. In the testing field 'Electro-conductivity / resistivity of materials', again, Lithuania exhibits a deficit (77.381%), whereby in the case of Germany an overage is visible (121.728%), which also applies for Latvia in the case of 'manufacturing processes verification' (116.827%). Regarding the testing service 'characterization & testing of batteries, solar cells & electrical systems', it is obvious that only for Estonia a moderate outcome is apparent (cf. Figure 5). The CSI value of Finland (83.333%) and to a certain extend also in the case of Lithuania (91.216%) reveal too low satisfaction scores in comparison to the achieved importance of this testing service. In contrast to this, the result for Latvia (118.519%) as well as to a certain degree also the one of Germany (113.077%) indicate oversaturation. In the frame of 'sound characterization' the need of action is present for Latvia (80%) and Finland (93.333%), which is in a similar way also slightly visible in the case of Lithuania (94.444%) in the frame of offered 'temperature & humidity environmental testing', compared with the achieved heavy deficit of Lithuania in the course of 'mechanical & structural characterization & testing' (84.615%). In the latter case ('mechanical & structural characterization & testing'), Estonian exhibits a grave overage (122.039%), whereby the resulting overhang of Estonia in the case of the testing service 'spectral responsivity of radiometric sensors' is even higher (128.571%). In comparison to this, there is need for action for Finish labs, since a CSI value of 81.818% indicates that the customers are not satisfied with the offered service 'spectral responsivity of radiometric sensors'. Similarities of deficits apply also in the case of 'calibration, characterization & measurements optical systems' in Finland (74.074%) and Latvia (90.909%). Due to the low interest of especially Finish companies for 'Bio-electromagnetic testing (on live cells and model organisms)', the respective CSI value was not determinable, whereby for Estonia a deficit (81.25%) and for Lithuania a great overage (150%) was detectable.

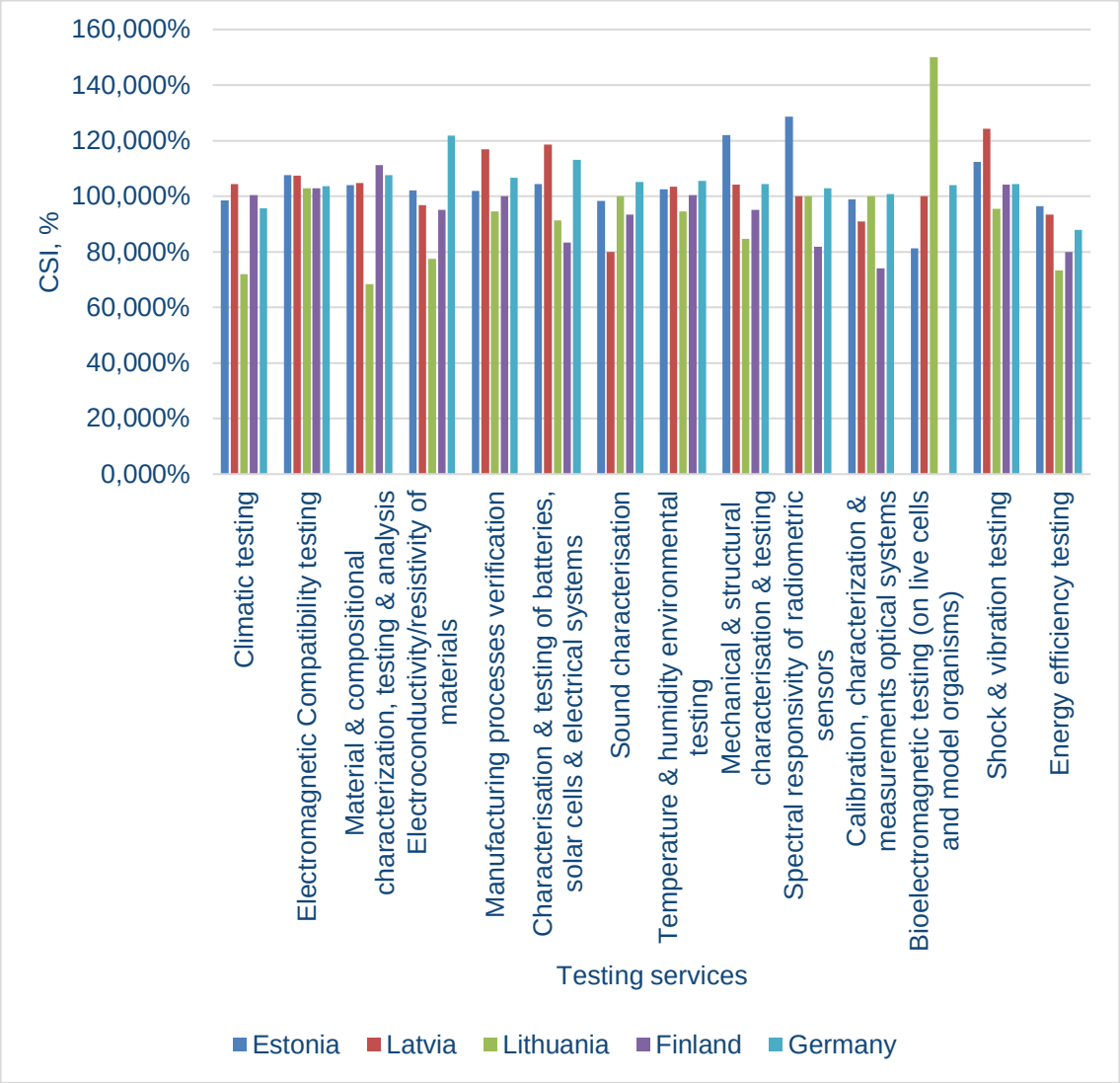

Figure 5. CSI – national level.

Source. Authors' illustration and compilation

The big variance between the target and actual values in the service area 'shock & vibration testing', which was noticed in the overall BSR sample (cf. Table 2), has his origin in the strong overhang of satisfaction scores in comparison to the evaluated importance by customers in Estonia (112.375%) and Latvia (124.224%). Against this, the identified deficit of the BSR in the 'energy efficiency testing' field (cf. Table 2), can

be traced back to the poor assessment of satisfaction by companies from Latvia (93.333%), Lithuania (73.333&), Finland (80%) and Germany (87.931%).

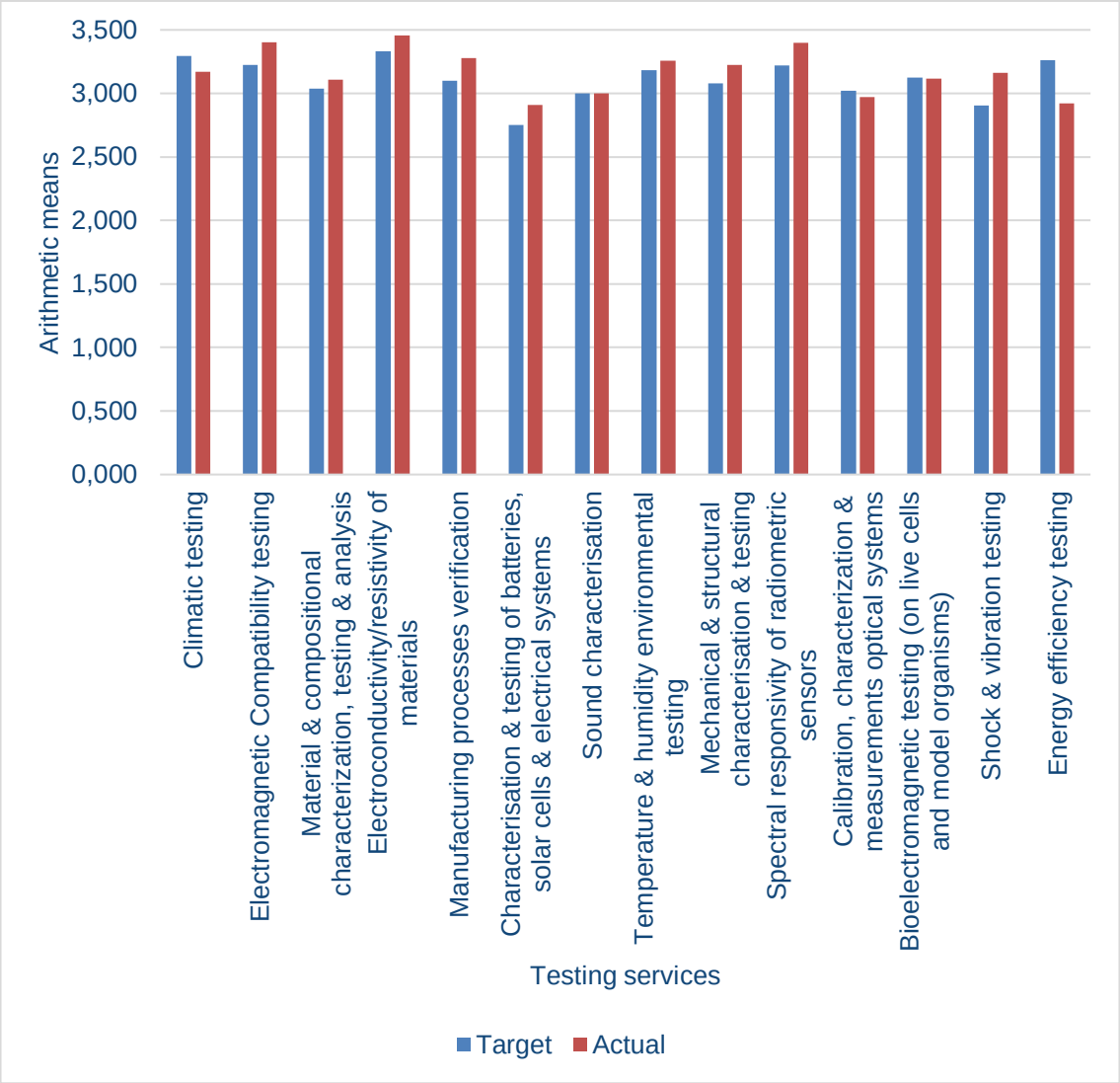

Figure 6. Target / actual comparison – BSR.

Source. Authors' illustration and compilation

These predications are also confirmed through the graphical evaluation of the results of the customer satisfaction analysis in form of a graphical target / actual comparison by using the arithmetic mean values, which is exemplified here by the results on entire BSR level in Figure 6. By having a closer look to the target / actual comparison, Figure

6 shows that the expected requirement to the service ‘energy efficiency testing’ could not be met, since the current valuation from the customers perspective is with 0.338 valuation points below the desired target score. On the other hand, the positive gap of about 0.256 valuation points between the actual and target value in the case of the service ‘shock & vibration testing’ is particularly high. For the other 12 testing services, there are no such serious deviations as for ‘energy efficiency testing’ and ‘shock & vibration testing’.

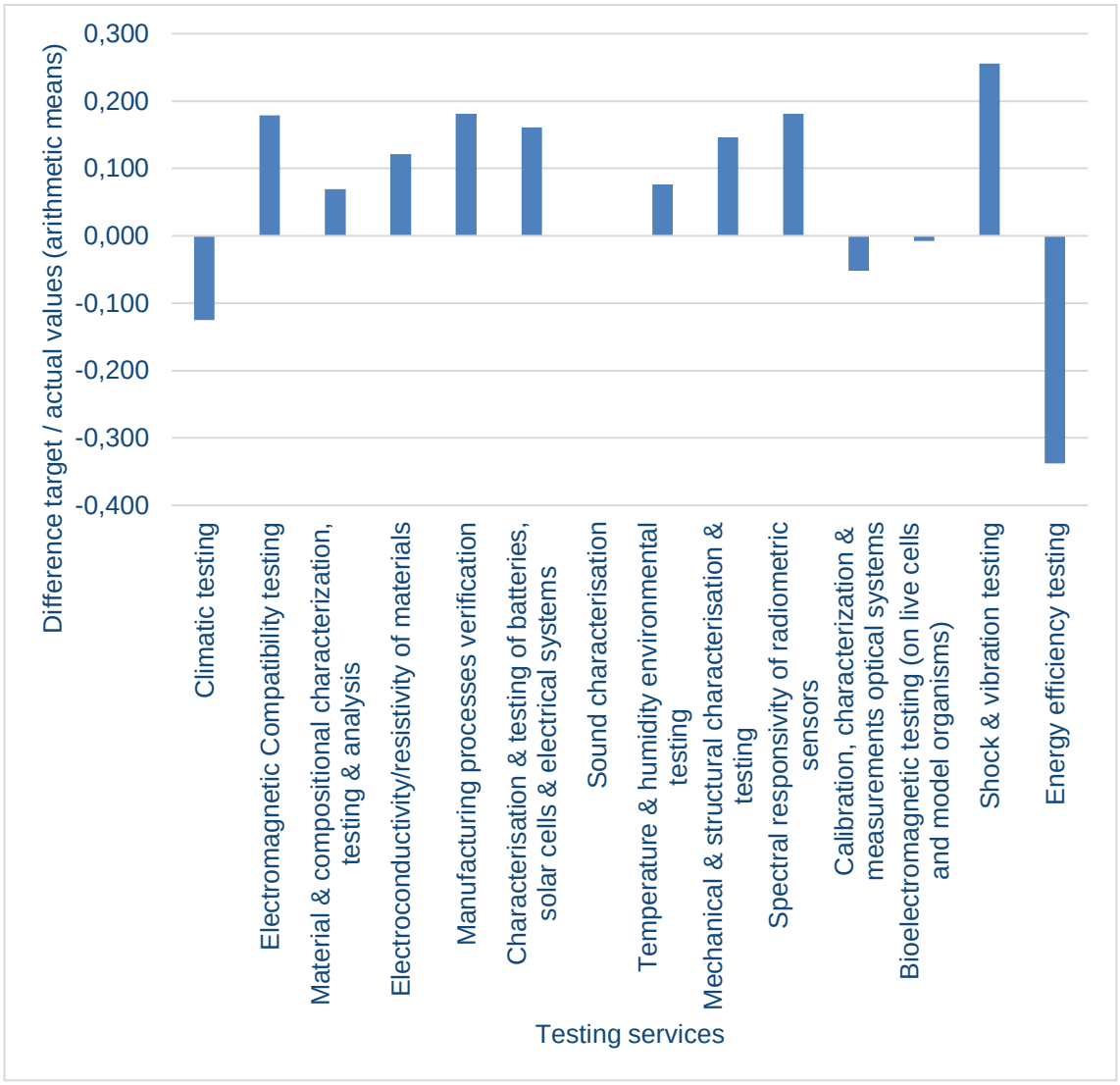

Figure 7. Difference target / actual values (arithmetic means) – BSR.

Source. Authors’ illustration and compilation

These previous findings are also validated by the comparison of the differences of the arithmetic means – highlighted in Figure 7 and 8 – which visualize the target / actual comparison from another perspective. In contrast to the direct target / actual comparison, the consideration of the differences in the arithmetic mean values also deliver that the aggregated and sophisticated view of the results in the case of the entire BSR indicates a possible need for action in the frame of the service 'climatic testing' (cf. Figure 7). Furthermore, from Figure 8, it is obvious that especially the differences of the target and actual values in the case of Lithuania are quite unbalanced and show great outliers in comparison to the results of the other four countries. Moreover, in the case of the related Finish results, it can be stated that in the course of some testing service fields, namely 'characterization & testing of batteries, solar cells & electrical systems', 'spectral responsivity of radiometric sensors', 'calibration, characterization & measurements optical systems' and 'energy efficiency testing', the deviations between the target and actual values are quite high, which underpinned once again an acute need for action for laboratories and testing institutions in Finland. In all cases shown here, the comparison of the target and the actual values or the resulting CSI values represent a current presentation of the strengths and weaknesses of testing services offered by laboratories in the BSR from customer perspective.

In an additional step, the participants were asked to specify the testing infrastructure, which is partly or completely missing in the reasonable proximity of their firm side. Due to the widely spread answers a content analysis made less sense. Accordingly, the results thereof are summarised in Table 4 according to their specific national affiliation.

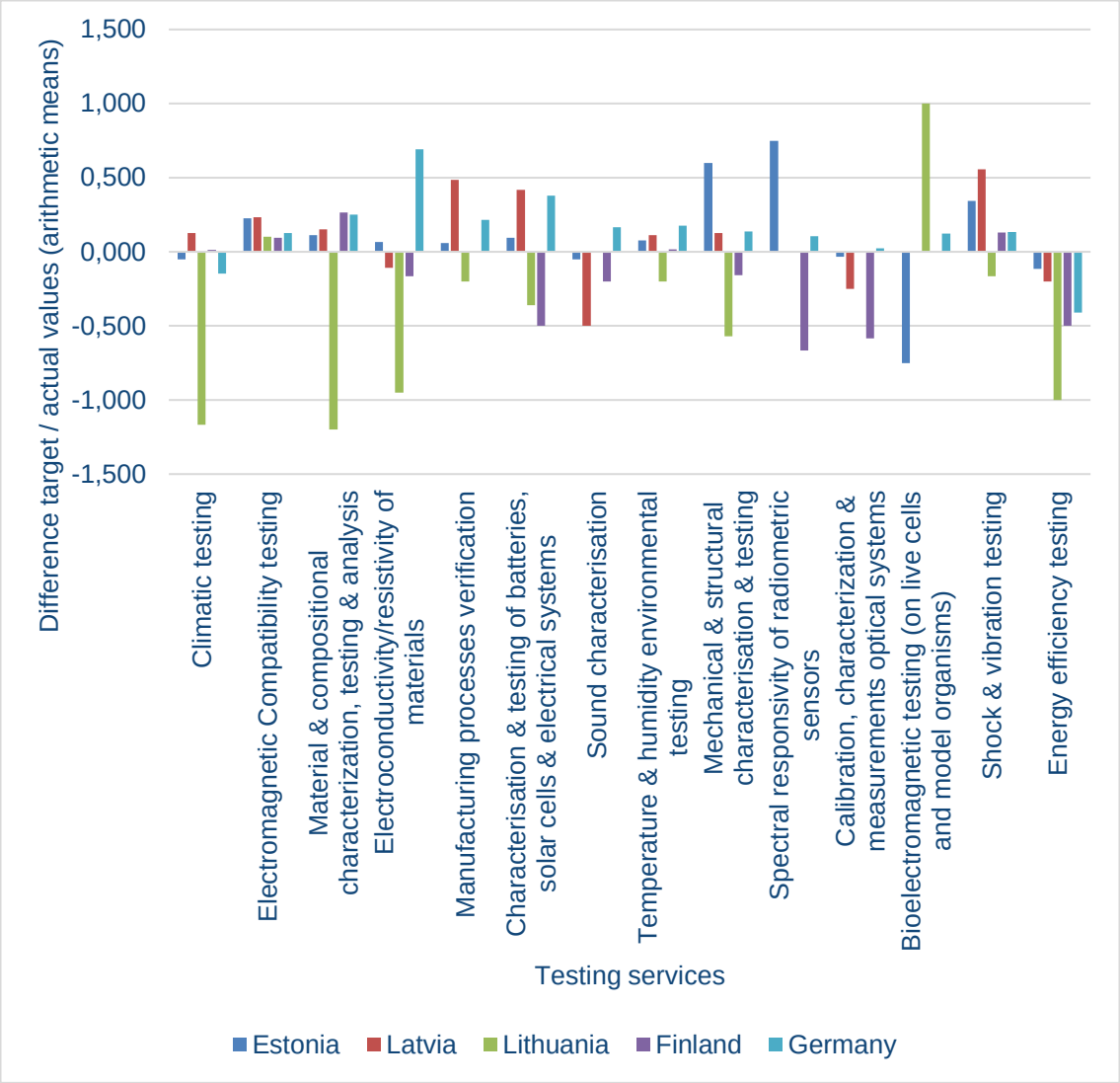

Figure 8. Difference target / actual values (arithmetic means) – national level.

Source. Authors' illustration and compilation

Table 4: Partly or completely missing testing infrastructure

	Estonia	Latvia	Lithuania	Finland	Germany
Testing infrastructure, which is partly or completely missing in the reasonable proximity of company	Mechanical resistance tests, wood climate tests for details over 50 cm, light measurements. Radio communication, GSM GSM, Bluetooth, Wifi Modem Testing Devices There are no direct shortcomings, but testing for electromagnetic compatibility and verification of radios tends to be expensive. EMC (electromagnetic compatibility) Device for studying ultrasonic cavitation in an aqueous environment. GSM Modem Testing Equipment. Bluetooth, Wifi Radio communication, GSM	Digital testing of prototype wiring. Various electrical resistance tests. Low-speed electric transport certification; Competent advice on the need for certification and / or component certification, requirements, certification authority. Unfortunately, businesses need to be persuaded to understand what it is imperative to certify, to be tested in order to work safely and properly on the European market. Compliance with FCC and IC Compliance with automotive industry requirements Specific material testing Testing according to MID and 2014/53 / EU Directives Residual Gas Analysis, Total Ionization Dose, Single Event Effect The problem is not with the infrastructure, but with the information on what needs to be tested. ENEC (European Norms Electrical Certification) Solar, salt test, thermal shock test, vibration test	Solar cell and silicon wafer detection and analysis equipment. Infrastructure for measuring double-sided and back contact solar cell and module characteristics. Testing of photovoltaic modules according to IEC61215 and IEC61730 Electro-optical devices Calibration, Characterization and Measurement of Optical Systems, Verification of Production Processes Impact and vibration testing (no. 13 of testing services) Electronics testing	Lack of accreditation in test laboratories that is required by quality system (e.g. IATF). Testing can be made only with special permission of client. In EMC testing the tolerance of 30 V/m in radiation disturbance Accredited EMC, Vibration and climate testing; Ingress Protection testing; IK testing Vibration test in climate chamber CE or E approval testing Damped oscillatory Part of the immunity testing Inexpensive company offering measurement of light intensity and light shape. Now service providers are relatively expensive. It is difficult to find from Finland apparatus that can test 1500g >0.5ms category acceleration/stroke. The mass of test subjects we have is << 1 kg (typically <0.5 kg) Energy efficiency We're not aware of provider for EMC for mobile machinery Solar collector testing and accreditation	Grid load test in the broadband sector Optical tests EMC testing capabilities Fine motor tests micro tests Nano technological tests High power laser testing Transnational IT security Electromagnetic compatibility Network Analysis Electromagnetic compatibility Depending on the order situation, e.g. electromagnetic tests

Source. Authors' illustration and compilation

3.2 Reasons for gaps in testing services

In order to analyse the sources for perceived low availability of testing infrastructure and accessibility to the required testing services in the region, the electronic products producing companies in the BSR had been asked to indicate the reasons. The results thereof are highlighted in Figure 9, 10, 11 and 12. The obtained results from electronic products producing companies in the BSR revealed that the main reasons for a perceived low availability of testing infrastructure in the region is often seen in the general low demand for testing services (57.391%), followed by the lack of qualified personnel, who can carry out the required tests (26.957%) – as highlighted in Figure 9.

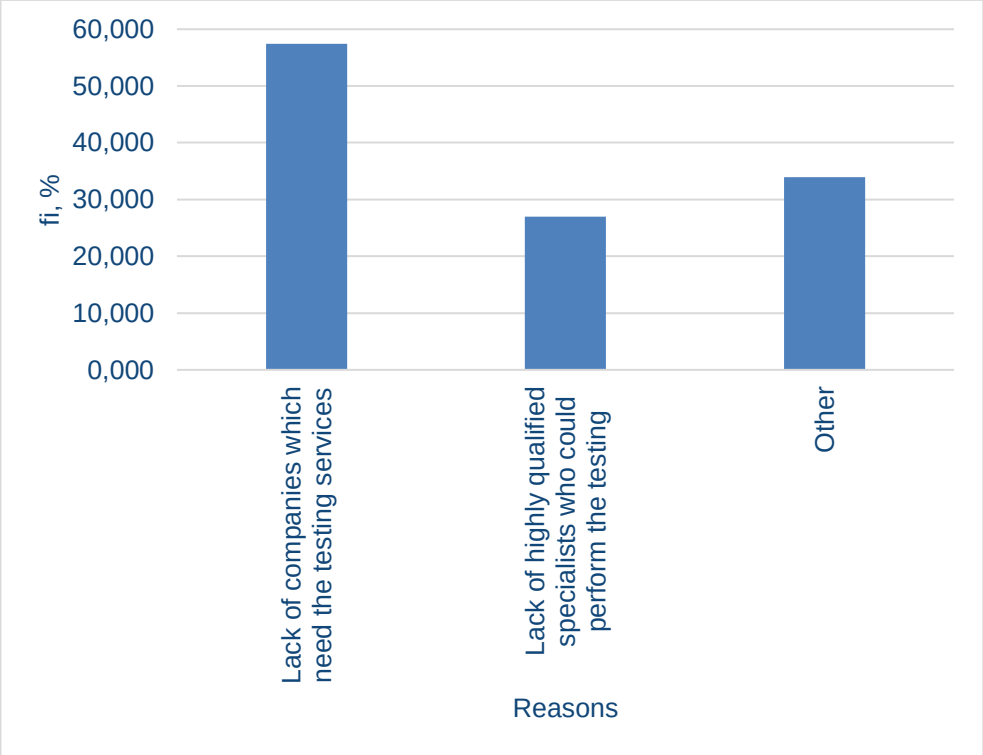

Figure 9. Reasons for low availability of testing infrastructure – BSR.

Source. Authors' illustration and compilation

These findings are congruent with the results on national level, where consistently the 'lack of companies which need the testing services' had been pinpointed by the companies of each country as the main reason for the low availability of testing infrastructure (cf. Figure 10). Nevertheless, for Estonian (59.091%), Latvian (73.333%) and German (60%) companies, this reason of low demand was more relevant than for companies from Lithuania (50%) and Finland (45.455%). However, of less relevance was the reason that there exist a 'lack of highly qualified specialists who could perform the testing'. Especially for Estonian (27.273%), Latvian (46.667%), Lithuanian (35.714%), and Finish (22.727%) companies this reason has less – but notable – relevance, whereby in the case of Germany only 10% of the firms confirmed the lack of testing specialists.

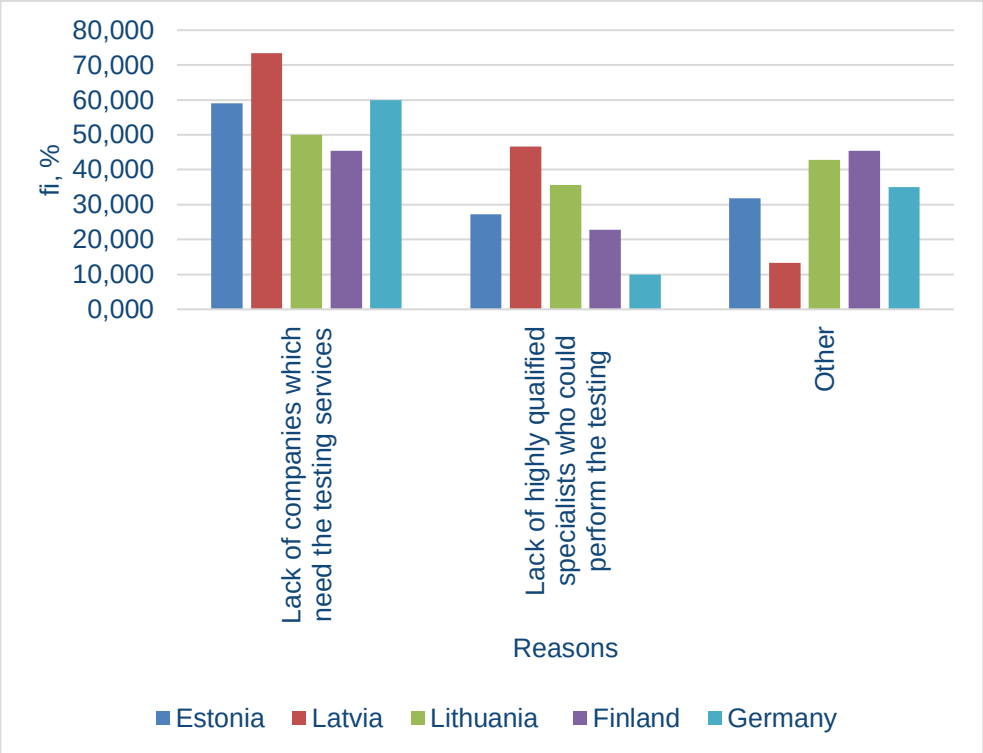

Figure 10. Reasons for low availability of testing infrastructure – national level.

Source. Authors' illustration and compilation

Furthermore, in the frame of the answer option ‘other’, the received answers were widely dispersed. Accordingly, content analyses were performed in order to summarize and group the individual answers to topic related areas, whereby in the following the highlighting of individual country specific peculiarities shall be sufficient. The compiled detail results (raw data) thereof are showcased in Appendix I (reasons for low availability) and J (reasons for low accessibility).

In the frame of the answer option ‘other’ in the case of reasons for low availability, companies from Estonia indicated that it is not easy to figure out who is offering testing services and that the legislation is still in creation, which can be both regarded under the umbrella of missing awareness. Further national peculiarities were identified in case of Lithuanian companies, who stated that for their own purposes the available measurement equipment is not adapted to the next generation (e.g. for tests on solar cells and modules) and that the nearest available infrastructure is in Germany. Another Lithuanian company mentioned that in their immediate surrounding, there are no accredited institutions, who are capable of performing optical and temperature measurements. In a similar way, also Finish companies clarified that only few accredited laboratories exist in their region. Additionally, a German company specified that due to political interest, specific tests are not wanted, which from company's’ perspective are normally desirable. Other German companies indicated that reasons for low availability of testing infrastructure in their region can be related to high costs, historical development, the niche application of own products and that no test institutes are specialised in aviation technology and loads, whereby the two latter cases are also attributable to the lack of qualified personnel.

Against this, the two major reasons for a low accessibility to the required testing services in the region, which were mentioned by electronic components producing companies, were the ‘high costs’ (32.174%) that are related to the claiming of testing services, as well as the low awareness of either utilization rules or frames of the available infrastructure (30.435%) – as shown in Figure 11. Other reasons, which had

been less stated in this context, are the 'high utilization rate of the required testing infrastructure and the associated long waiting time (14.783%), as well as the restricted or limited accessibility, which is imposed by owners of the required testing infrastructure (12.174%). Notable in this context is that especially the alternative answer option 'other' was chosen by 38.261% of the participants, which represents the majority. This leads to the conclusion that the four predefined reasons do not sufficiently covered the main arguments for a low accessibility to the required testing services.

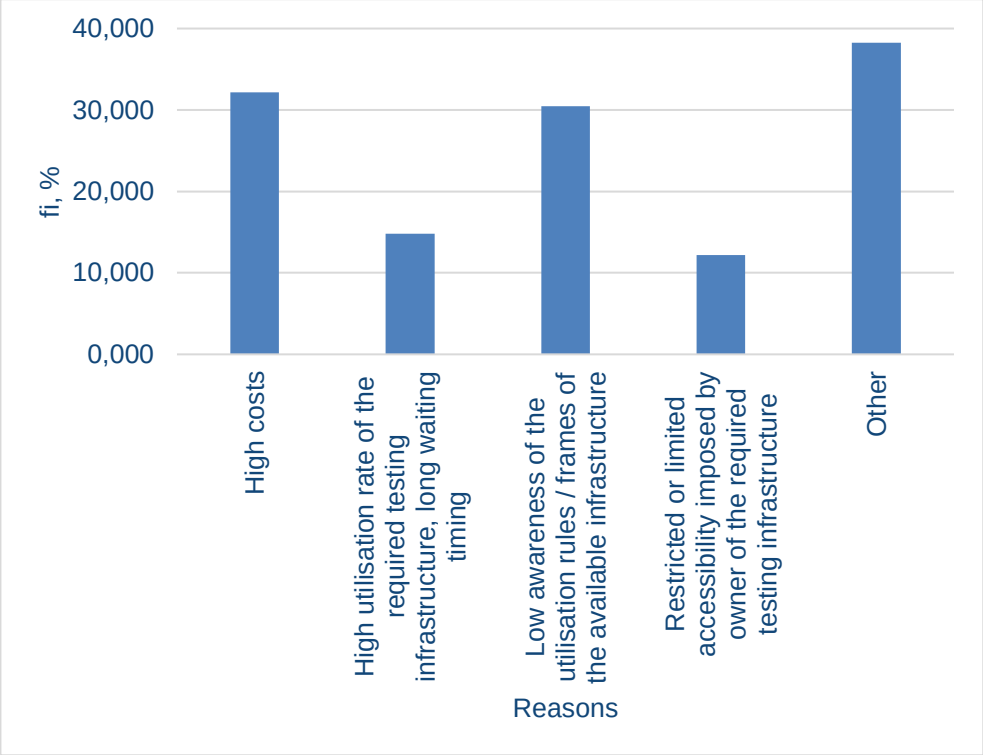

Figure 11. Reasons for low accessibility to the required testing services – BSR.

Source. Authors' illustration and compilation

This ambiguity or potential disagreement is also reflected by the results on national level in Figure 12. Only in the Estonian and Latvian partial samples, similar results as on entire BSR level are obvious, since in both cases the major reasons for a perceived low accessibility to the required testing services are seen in the 'high costs' (EE =

20.455%, LV = 33.333%) as well as the 'low awareness of the utilisation rules / frames of the available infrastructure' (EE = 38.636%, LV = 66.667%), followed by the two minor relevant reasons 'high utilisation rate of the required testing infrastructure, long waiting timing' (EE = 9.091%, LV = 13.333%) and 'restricted or limited accessibility imposed by owner of the required testing infrastructure' (EE = 9.091%, LV = 20%). In the case of Lithuanian companies, the single major reason for a low accessibility to the required testing services is regarded in the related 'high costs' (42.857%), followed by 'high utilisation rate of the required testing infrastructure, long waiting timing' (28.571%) and 'restricted or limited accessibility imposed by owner of the required testing infrastructure' (21.429%), whereby the reason 'low awareness of the utilisation rules / frames of the available infrastructure' has no relevance (0%) from the perspective of Lithuanian firms. In contrast to this, this latter reason ('low awareness of the utilisation rules / frames of the available infrastructure') represents the most important one for Finish companies (38.818%), followed by 'high costs' (22.727%) and 'high utilisation rate of the required testing infrastructure, long waiting timing' (22.727%), while the reason 'restricted or limited accessibility imposed by owner of the required testing infrastructure' denotes a subordinate reason for Finish companies (4.545%). For German companies, 'high costs' is the dominant argument for the low accessibility to the required testing services (60%). The other three arguments are of lower relevance for German companies, since the relative frequency ranks only from 5 to 15%.

Peculiarities, which had been mentioned by Estonian companies in the frame of this topic (reasons for low accessibility to the required testing services) under the answer option 'other', were that the necessary equipment is not existing in Estonian labs, and that there is a lack of demand, experience and again legislation. Generally, the mentioned weak point of missing awareness was especially objected by Estonian and Latvian companies. Another Latvian firm as well as Finish companies stated that generally there is not enough test supply due to the small number of labs. Against this, for Lithuanian companies causally is the low demand. By regarding both arguments together, this leads to the possible conclusion of the existence of a chicken-and-egg-

problem – what comes first: demand or supply. Moreover, a German company mentioned that especially laboratories face high fix costs for the purchase of (up-to-date) equipment, which has a deterrent effect on testing institutions and their offer due to risk aversion.

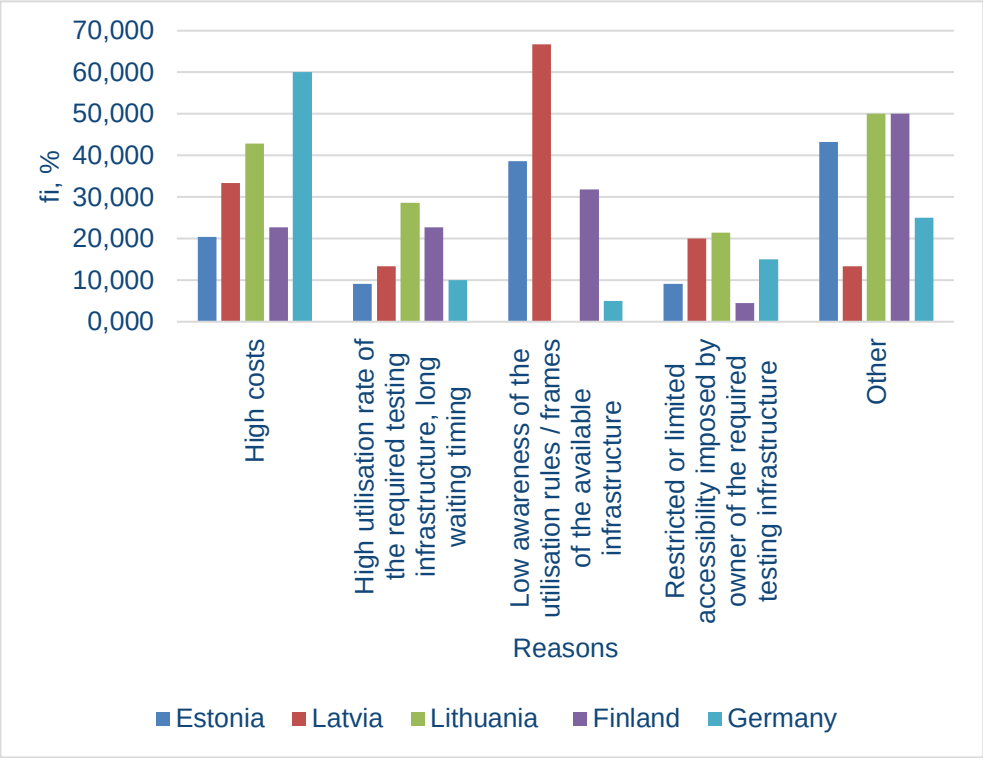

Figure 12. Reasons for low accessibility to the required testing services – national level.

Source. Authors' illustration and compilation

3.3 Demanded product standards and testing institutions for Certificate of Conformity

In order to analyse the demand of testing services, in a first step, companies, who participated in the online survey, had been asked to list the standards to which their products must comply in order to receive the Certificate of Conformity. The number of different standards to which the products of the individual firms must show compliance

are manifold. Accordingly, the content analysis was performed once again, in order to figure out the greatest interest in standards of electronic products producing companies in the BSR. The results thereof are summarized in Table 5, whereby the original collected data is overviewed in Appendix K. For the purposes of analysis in the following, the location parameter mode or the relative frequency, respectively, are used once again. By having a closer look to the elaborated results of Table 5, it becomes obvious that the most important standards for electronic manufactures in the BSR and the related obtainment of the Certificate of Conformity are ‘EN’ (21.569%), ‘ISO’ (16.667%) and ‘IEC’ (11.765%). Further standards that are more or less of high relevance are the standards ‘EMC’ (7.843%), ‘CE’ (8.824%) and ‘DIN’ (6.863%).

These overall results depend of the individual partial results and therefore largely show parallelisms, whereby the individual preferences in the different partial samples differ to a certain degree. For instance, for Estonian companies, the most important product standards that must be fulfilled in order to receive the Certificate of Conformity are the ‘EN' (29.630%), ‘ISO’ (11.1115) and ‘EMC’ (18.519%). Against this, for Latvian companies the most relevant product standards are the ‘EN’ (35.714%), ‘IEC’ (14.286%) and the ‘ETSI’ (14.286%), whereby the standard ‘ETSI’ was of no relevance for companies outside of Latvia in the online survey and thus represents an exception in this context. For Lithuanian companies, the highest relevance is attributable to the standards ‘EN’ (18.182%), ‘CE’ (36.364%) and the ‘IEC’ (45.455%), which at the same time embrace all mentioned product standards by Lithuanian firms. The highest standard preference for Finish firms in the frame of the Certificate of Conformity is noticeable for ‘EN’ (18.519%), ‘ISO’ (18.519%) and ‘IEC’ (14.815%). In contrast to this, big importance has the product standards ‘EN’ (8.696%), ‘ISO’ (39.130%), ‘CE’ (8.696%) and ‘DIN’ (26.087%) for companies from Germany.

Table 5: Product standards in order to receive Certificate of Conformity (content analysis)

	BSR		Estonia		Latvia		Lithuania		Finland		Germany	
Standards in order to receive Certificate of Conformity	**hi**	**fi (in %)**	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)
RoHS	**1**	**0,980**	1	3,704	0	0,000	0	0,000	0	0,000	0	0,000
EN (BEAB)	**22**	**21,569**	8	29,630	5	35,714	2	18,182	5	18,519	2	8,696
ISO	**17**	**16,667**	3	11,111	0	0,000	0	0,000	5	18,519	9	39,130
MIL-STD	**4**	**3,922**	2	7,407	0	0,000	0	0,000	2	7,407	0	0,000
EMC	**8**	**7,843**	5	18,519	0	0,000	0	0,000	2	7,407	1	4,348
LVD	**2**	**1,961**	2	7,407	0	0,000	0	0,000	0	0,000	0	0,000
SAR	**2**	**1,961**	2	7,407	0	0,000	0	0,000	0	0,000	0	0,000
IPC / WHMA	**1**	**0,980**	1	3,704	0	0,000	0	0,000	0	0,000	0	0,000
CE	**9**	**8,824**	2	7,407	1	7,143	4	36,364	0	0,000	2	8,696
NPPA	**1**	**0,980**	1	3,704	0	0,000	0	0,000	0	0,000	0	0,000
IEC	**12**	**11,765**	0	0,000	2	14,286	5	45,455	4	14,815	1	4,348
IN	**1**	**0,980**	0	0,000	1	7,143	0	0,000	0	0,000	0	0,000
ETSI	**2**	**1,961**	0	0,000	2	14,286	0	0,000	0	0,000	0	0,000
FCC	**1**	**0,980**	0	0,000	1	7,143	0	0,000	0	0,000	0	0,000
SAE	**1**	**0,980**	0	0,000	1	7,143	0	0,000	0	0,000	0	0,000
ESCC	**1**	**0,980**	0	0,000	1	7,143	0	0,000	0	0,000	0	0,000
ENEC	**2**	**1,961**	0	0,000	0	0,000	0	0,000	2	7,407	0	0,000
cULus	**1**	**0,980**	0	0,000	0	0,000	0	0,000	1	3,704	0	0,000
CQC	**1**	**0,980**	0	0,000	0	0,000	0	0,000	1	3,704	0	0,000
AEC	**1**	**0,980**	0	0,000	0	0,000	0	0,000	1	3,704	0	0,000
UNECE (E/ECE)	**2**	**1,961**	0	0,000	0	0,000	0	0,000	2	7,407	0	0,000
DIN (VDE)	**7**	**6,863**	0	0,000	0	0,000	0	0,000	1	3,704	6	26,087
AS/NZS	**1**	**0,980**	0	0,000	0	0,000	0	0,000	1	3,704	0	0,000
FDA 21 CFR 1040	**1**	**0,980**	0	0,000	0	0,000	0	0,000	0	0,000	1	4,348
ETSO	**1**	**0,980**	0	0,000	0	0,000	0	0,000	0	0,000	1	4,348
Total	***102***	***100,000***	*27*	*100,000*	*14*	*100,000*	*11*	*100,000*	*27*	*100,000*	*23*	*100,000*

Source. Authors' illustration and compilation

In a second step, the participating companies in the online survey had been asked to indicate the institutions they request for the final testing of their electronic products in order to get the Certificate of Conformity and to put their products on the market. The conducted content analysis delivered 32 different testing institutions – as shown in Table 6, whereby the summarised raw data is exhibited in Appendix L. For the evaluation of demand the mode and the relative frequency is used in the following.

As visible in Table 6, the most important testing institutions in order to receive the Certificate of Conformity in the BSR or eligible programme area (Interreg Baltic Sea Region Programme), respectively, are ‘Inspecta’ (11.765%), ‘RISE’ (4.412%), ‘SGS Fimko’ (11.765%), ‘LEITC’ (8.824%), ‘TÜV’ (8.824%), ‘Dekra’ (5.882%) and ‘University of Wismar’ (5.882%). This is true, since on the one hand, these testing institutions were most frequently mentioned by electronic products producing companies, and on the other hand – with exception of the ‘University of Wismar’ – these testing institutions had been mentioned in more than one partial sample. For instance, ‘Inspecta’ by companies from Estonia and Lithuania, ‘RISE’ and ‘SGS Fimko’ by firms from Estonia and Finland, ‘LEITC’ by companies from Estonia, Latvia and Lithuania, ‘TÜV’ by firms form Latvia and Lithuania as well as ‘Dekra’ by companies from Latvia, Finland and Germany. Accordingly, in this context, it needs to be highlighted that only ‘LEITC’ and ‘TÜV’ are demanded by several companies in three different BSR countries. As mentioned in sub-chapter 2.3 (sample description), ‘LEITC’ belongs to the Riga Technical University (PP3), who has his single location in Riga. Therefore, the previously mentioned finding – LEITC profits from its success factor “location” and the related geographical proximity to the neighbouring Baltic countries Estonia and Lithuania or these neighbouring markets, respectively (cf. sub-chapter 2.3 sample description), might be once again confirmed. On the other hand, these findings might be also traced back to the fact that ‘LEITC’ seems to have a good reputation with a good offer. Against this, ‘TÜV’ is a testing institution that is well-known and is active as

a company with a lot of labs in many different countries due to its strong market position.

In a similar way, as mentioned in sub-chapter 2.3 (sample description), here the most important testing institution in the frame of the application for the Certificate of Conformity for companies from Estonia that are active the electronic component market is ‘Inspecta’ (46.667%). In case of Latvian companies, the testing institution ‘LEITC’ (28.571%), for Lithuanian firms ‘TÜV’ (40%) and for Finish companies ‘SGS Fimko’ (31.579%) are the most important testing institution for final product testing in order to get the Certificate of Conformity and to put the electronic products on the market. In the German partial sample, the ‘University of Wismar’ was the testing institution, which was most often indicated (40%). Nevertheless, this result can be traced back to the circumstance that all PPs searched for potential participants for the online survey from and outside their own networks (cf. sub-chapter 2.1 data collection). Accordingly, for this reason, the participating companies from German side came primary from the near proximity (Mecklenburg-Western Pomerania) of PP8 (University of Wismar), which more or less led to this result of the highest relative frequency in the German partial sample. Therefore, this result in case of the German partial sample claims not to be generalizable. If the geographical scope of data collection would be extended to the entire German country, very likely TÜV, Dekra, Fraunhofer, etc. would be mentioned more often.

Table 6: Institutions whose services are used for final testing to get Certificate of Conformity and to put products on the market (content analysis)

	BSR		Estonia		Latvia		Lithuania		Finland		Germany	
Institutions used for final testing in order to receive Certificate of Conformity	**hi**	**fi (in %)**	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)
Inspecta	**8**	**11,765**	7	46,667	0	0,000	1	10,000	0	0,000	0	0,000
RISE (RI.SE)	**3**	**4,412**	2	13,333	0	0,000	0	0,000	1	5,263	0	0,000
SGS Fimko	**8**	**11,765**	1	6,667	0	0,000	0	0,000	6	31,579	1	10,000
Underwriter Laboratories	**1**	**1,471**	1	6,667	0	0,000	0	0,000	0	0,000	0	0,000
LEITC	**6**	**8,824**	1	6,667	4	28,571	1	10,000	0	0,000	0	0,000
BARCL	**1**	**1,471**	1	6,667	0	0,000	0	0,000	0	0,000	0	0,000
BV	**1**	**1,471**	1	6,667	0	0,000	0	0,000	0	0,000	0	0,000
Tallinn Brick	**1**	**1,471**	1	6,667	0	0,000	0	0,000	0	0,000	0	0,000
AITEX	**1**	**1,471**	0	0,000	1	7,143	0	0,000	0	0,000	0	0,000
TÜV	**6**	**8,824**	0	0,000	2	14,286	4	40,000	0	0,000	0	0,000
Roger Labs	**1**	**1,471**	0	0,000	1	7,143	0	0,000	0	0,000	0	0,000
FCC	**1**	**1,471**	0	0,000	1	7,143	0	0,000	0	0,000	0	0,000
IC	**1**	**1,471**	0	0,000	1	7,143	0	0,000	0	0,000	0	0,000
TestLab	**1**	**1,471**	0	0,000	1	7,143	0	0,000	0	0,000	0	0,000
Alter Technology	**1**	**1,471**	0	0,000	1	7,143	0	0,000	0	0,000	0	0,000
Dekra	**4**	**5,882**	0	0,000	2	14,286	0	0,000	1	5,263	1	10,000
Fraunhofer	**1**	**1,471**	0	0,000	0	0,000	1	10,000	0	0,000	0	0,000
ISC-Konstanz	**1**	**1,471**	0	0,000	0	0,000	1	10,000	0	0,000	0	0,000
UAB Bureau Veritas Lit	**1**	**1,471**	0	0,000	0	0,000	1	10,000	0	0,000	0	0,000
RRT	**1**	**1,471**	0	0,000	0	0,000	1	10,000	0	0,000	0	0,000
IMQ	**1**	**1,471**	0	0,000	0	0,000	0	0,000	1	5,263	0	0,000
SEMKO	**1**	**1,471**	0	0,000	0	0,000	0	0,000	1	5,263	0	0,000
Centria	**2**	**2,941**	0	0,000	0	0,000	0	0,000	2	10,526	0	0,000
G4C (Grant4COM)	**2**	**2,941**	0	0,000	0	0,000	0	0,000	2	10,526	0	0,000
Etteplan	**2**	**2,941**	0	0,000	0	0,000	0	0,000	2	10,526	0	0,000
Delta	**1**	**1,471**	0	0,000	0	0,000	0	0,000	1	5,263	0	0,000
IEC	**1**	**1,471**	0	0,000	0	0,000	0	0,000	1	5,263	0	0,000
SPF Swirzerland	**1**	**1,471**	0	0,000	0	0,000	0	0,000	1	5,263	0	0,000
Department of energy	**1**	**1,471**	0	0,000	0	0,000	0	0,000	0	0,000	1	10,000
CEcert	**2**	**2,941**	0	0,000	0	0,000	0	0,000	0	0,000	2	20,000
University of Wismar	**4**	**5,882**	0	0,000	0	0,000	0	0,000	0	0,000	4	40,000
Dynamic Test Center	**1**	**1,471**	0	0,000	0	0,000	0	0,000	0	0,000	1	10,000
Total	***68***	***100,000***	*15*	*100,000*	*14*	*100,000*	*10*	*100,000*	*19*	*100,000*	*10*	*100,000*

Source. Authors' illustration and compilation

4. Conclusion

In this report the identification and analysis on gaps in testing services in the BSR was investigated. The research revealed that there exist significant differences in testing supply in the BSR and the participating member states and thus, there exist gaps of testing services in the region. Moreover, through the two-component approach, it was detected that on entire BSR level, especially in the frame of the testing service 'energy efficiency testing' there is need for action in form of investments. Against this, the research further showed that in the course of the testing service 'shock & vibration testing' an oversaturation is indicated in the region, which leads to the recommendation of a potential disinvestment, since in this specific testing service field surpassingly satisfaction was achieved through customers valuation, namely electronic products producing SMEs, which is often associated with satisfaction deficits in other important services, like 'energy efficiency testing'.

On national level, it was identified by the investigation that in the case of Estonia there is a need for action or investment, respectively, for the testing service 'bio-electromagnetic testing (on live cells and model organisms)'. In contrast to this, overages were pinpointed in the frame of the testing services 'mechanical & structural characterization & testing' and 'spectral responsivity of radiometric sensors' as well as 'shock & vibration testing'. Deficits in the Latvian testing landscape are noticeable for 'sound characterization', 'calibration, characterization & measurements optical systems' and 'energy efficiency testing', whereby oversaturation was achieved in case of 'manufacturing processes verification', 'characterization & testing of batteries, solar cells & electrical systems' and 'shock & vibration testing'. Among all examined countries, the results from the Lithuanian partial sample were sharp unbalanced. This is certified by testing SMEs, who indicated low satisfaction in a broad band of testing services, namely 'climate testing', 'material & compositional characterization, testing & analysis', 'electro-conductivity / resistivity of materials', 'characterization & testing of

batteries, solar cells & electrical systems', 'temperature & humidity environmental testing', 'mechanical & structural characterization & testing' and 'energy efficiency testing'. Vice versa, compared with all other participating countries, Lithuania exhibits the greatest overage in supply satisfaction in case of the testing service 'bio-electromagnetic testing (on live cells and model organisms)'. Similarities were apparent in Finland, were the number of testing deficits were also quite high. Accordingly, urgent investments are needed in the course of the testing services 'characterization & testing of batteries, solar cells & electrical systems', 'sound characterization', 'spectral responsivity of radiometric sensors', 'calibration, characterization & measurements optical systems' as well as 'energy efficiency testing'. Only for 'material & compositional characterization, testing & analysis' a potential disinvestment is indicated by the research results. In Germany, a need for action is solely apparent again in the case of the testing service 'energy efficiency testing', whereby overages had been identified for 'electro-conductivity / resistivity of materials' and 'characterization & testing of batteries, solar cells & electrical systems'.

The findings on entire BSR level represent the overall aggregated results or holistic picture, respectively, which consist of the detail results of the individual investigated five countries, namely Estonia, Latvia, Lithuania, Finland and Germany. Accordingly, the big variance in the frame of the testing service 'shock & vibration testing', which was noticed on entire BSR level, has its origin in the strong overhang of satisfaction scores – in comparison to the evaluated importance – by customers in Estonia and Latvia. Against this, the identified deficit of the BSR in the 'energy efficiency testing' field, can be traced back to the poor assessment of satisfaction by companies from Latvia, Lithuania, Finland and Germany. Furthermore, the differences of the arithmetic means (target and actual values) on holistic BSR level revealed in addition a possible need for action in the frame of the service 'climatic testing'.

In all cases shown here, the comparison of the target and the actual values or the resulting CSI values denote a current presentation of the strengths and weaknesses

of testing services offered by laboratories in the BSR from customer perspective. Nevertheless, the elaborated results do not claim not to be generalizable. This is deeply rooted in the fact that all PPs searched for potential participants for the online survey – which served as an examination basis – from and outside their own networks (cf. sub-chapter 2.1 data collection). Accordingly, for this reason, the participating companies came primary from the environment of the PPs. Therefore, the presence of bias cannot be precluded. However, undoubtable, the showcased research results grant an insight and overview about the current situation of gaps and deficits in testing services in the BSR.

Hence, the identified gaps in testing services are summarised in Table 7. Thereby, a need for action or investment, respectively, on entire BSR level as well as on nation level is indicated with '↑'. Against this, an oversaturation or potential disinvestment, respectively, is symbolised through '↓'. Lastly, '0' represents an ideal range in the relationship between the established satisfaction and the desired importance – the state in which satisfaction and importance are almost in balance. In addition, the integrated respective colours show the degree of the needed investment or disinvestment, whereby the following legend gives an overview about the categorisation according to the received CSI values (x):

- $x \leq 85\%$ ≙ 'red'
- $85\% < x \geq 90\%$ ≙ 'orange'
- $90\% < x \geq 95\%$ ≙ 'yellow'
- $95\% < x \geq 110\%$ ≙ 'green'
- $110\% < x \geq 120\%$ ≙ 'yellow'
- $120 < x \geq 130\%$ ≙ 'orange'
- $x > 130\%$ ≙ 'red'

Table 7: Identified gaps in testing services and the recommended investment or disinvestment

Testing services	BSR	Estonia	Latvia	Lithuania	Finland	Germany
Climatic testing	(↑)	0	0	↑	0	0
Electromagnetic Compatibility testing	**0**	0	0	↑	0	0
Material & compositional characterization, testing & analysis	**0**	0	0	0	↓	0
Electroconductivity/resistivity of materials	**0**	0	0	↑	0	↓
Manufacturing processes verification	**0**	0	↓	0	0	0
Characterisation & testing of batteries, solar cells & electrical systems	**0**	0	↓	↑	↑	↓
Sound characterisation	**0**	0	↑	0	↑	0
Temperature & humidity environmental testing	**0**	0	0	↑	0	0
Mechanical & structural characterisation & testing	**0**	↓	0	↑	0	0
Spectral responsivity of radiometric sensors	**0**	↓	0	0	↑	0
Calibration, characterization & measurements optical systems	**0**	0	↑	0	↑	0
Bioelectromagnetic testing (on live cells and model organisms)	**0**	↑	0	↓	0	0
Shock & vibration testing	(↓)	↓	↓	0	0	0
Energy efficiency testing	↑	0	↑	↑	↑	↑

Source. Authors' illustration and compilation

The main reasons for a perceived low availability of testing infrastructure in the region is often seen in the general low demand for testing services, followed by the lack of qualified personnel, who can carry out the required tests. These findings are congruent with the results on national level. Accordingly, it can be concluded that one major measure in order to overcome these gaps, can be seen in the need to conduct trainings of personnel, so that they are enabled to perform the demanded tests. Therefore, it should be noted that from customer perspective the main reason for the existence of gaps in testing services in the region is not primary seen in the missing technological equipment, but more in the missing of capabilities on qualified personnel side. Mentioned technological gaps in this context are (cf. Table 4 – sub-chapter 3.1 identification and analysis of gaps in testing services) in:

Estonia, e.g. instruments for

- ‘mechanical resistance tests’, ‘wood climate tests for details over 50 cm’, ‘light measurements’,
- ‘radio-communication, GSM, Bluetooth, Wi-Fi modem testing’ and
- ‘EMC (electromagnetic compatibility)’ testing as well as
- ‘studying ultrasonic cavitation in an aqueous environment’;

Latvia, e.g. equipment for

- ‘digital testing of prototype wiring’ and ‘various electrical resistance tests’,
- ‘specific material testing’,
- ‘residual gas analysis’, ‘total ionization dose’, ‘single event effect’ and
- ‘solar, salt test, thermal shock test, vibration test’;

Lithuania, e.g.

- ‘solar cell and silicon wafer detection and analysis equipment’ as well as ‘infrastructure for measuring double-sided and back contact solar cell and module characteristics’,
- equipment for ‘testing of photovoltaic modules’,
- ‘electro-optical devices’,
- instruments for ‘calibration, characterization and measurement of optical systems’ as well as ‘verification of production processes’,
- devices for ‘impact and vibration testing’ and
- equipment for ‘electronics testing’;

Finland, e.g. devises for

- ‘EMC testing’ with a ‘tolerance of 30 V/m in radiation disturbance’,
- ‘EMC, vibration and climate testing, ingress protection testing, IK testing’,
- ‘vibration test in climate chamber’,
- ‘damped oscillatory’,
- ‘immunity testing’,
- testing ‘1500g > 0.5ms category acceleration/stroke’,
- ‘energy efficiency’ and
- ‘solar collector testing’;

in Germany, e.g. apparatus for

- ‘grid load test in the broadband sector’
- ‘optical tests’
- ‘fine motor tests’, ‘micro tests’, ‘nano-technological tests’,
- ‘high power laser testing’,
- ‘transnational IT security’,
- EMC as well as

- ‘network analysis’.

Against this, the two major reasons for a low accessibility to the required testing services in the region, which were mentioned by electronic components producing companies, were the ‘high costs’ that are related to the claiming of testing services, as well as the low awareness of either utilization rules or frames of the available infrastructure. Accordingly, it can be concluded that further activities that target to overcome the identified gaps in testing services, should focus on improving attractive pricing for testing services as well as creation of awareness of utilization rules and frames of the available infrastructure in the BSR.

By a joint analysis of all mentioned major reasons for the presence of gaps in testing services by customers, it can be stated that one first step was already taken in order to overcome these gaps in testing services. This first important step can be seen in the establishment of the EU-project TEST-4-SME, since the project among other things targets to create product testing competence centres network and to establish a long-term network with sustainability actions in order to:

- raise knowledge and awareness among SMEs,
- map the electronics testing labs in the BSR,
- purchase hardware and to invest into testing equipment,
- offer trainings to testing personnel of laboratories (in order to improve the capabilities of the qualified staff),
- create and deliver product testing services
- research ideal price-point of services,
- establish a long-term sustainability strategy for the BSR,
- etc.

Accordingly, by taking into account all findings from the conducted research for the identification and analysis of gaps in testing services, this planed bundle of measures from the EU-project TEST-4-SME penetrate all pinpointed areas of challenges that are related to testing services in the BSR. Through this, a sustainable development of SMEs that produce electronic products in the BSR will be secured. Additionally, especially, by taking into account, that the OECD (2009) identified the insufficient match with export product quality, standards and specifications, and listed it as a top ten barrier for SMEs in the frame of internationalisation efforts; this project will have not only a direct positive effect on respective SMEs, but also moreover will have great positive effects on the environment, labour market, innovations, society and economy of the entire BSR and beyond, due to the enabled and supported internationalisation process of these SMEs.

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Appendix

Appendix A: Online survey – English version

Dear participant

This research is being done to initiate an innovation support network with a shared knowledge in the BSR to provide testing for electronics SMEs to comply with the international standards during the early product development stage, which helps avoiding costly failures in later stages. TEST-4-SME works with members located in the BSR and seven pilot SMEs to test the network's services. The aim is to provide an expertise advise, and train staff in a wide range of testing methods to comfort standards needed by electronic producers.

The aim of the survey "Mapping Testing Services in Baltic Sea Region" is to identify and analyse the gaps, e.g. technical expertise or lack of hardware, in testing services as well as clarify SMEs' needs for electronic product or devices testing services in the region.

The survey will be completed by the company based on experience, knowledge, quantitative and qualitative data about the company. Minimum data about the company is collected in order to analyze the needs of different types of enterprises. The provided data will be treated confidentially and will be used for research and scientific purposes only.

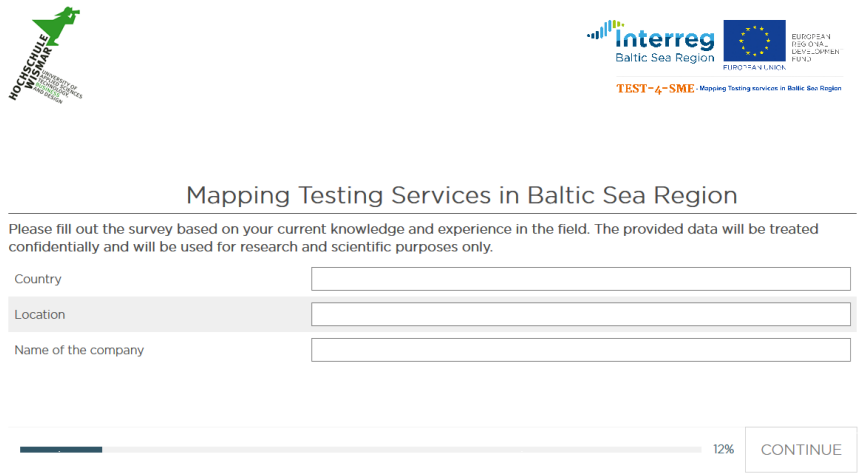
This consent form asks you to allow the researcher to record and use your comments to enhance understanding of the topic. The form also asks your permission to use related observations & posts as data in this study. Participation in this study is completely voluntary. If you decide not to participate there will not be any negative consequences. Please be aware that if you decide to participate, you may stop participating at any time and you may decide not to answer any specific question.

The researcher will maintain the confidentiality of the research records or data, and all data will be achieved in order to make them available for other developments in line with current European Union Data sharing act. By agreeing on this form you are indicating that you have read the description of the study, and that you agree to the terms as described.

Thank you in advance for agreeing to participate in this survey.

TEST-4-SME team

6% CONTINUE



Mapping Testing Services in Baltic Sea Region

Please fill out the survey based on your current knowledge and experience in the field. The provided data will be treated confidentially and will be used for research and scientific purposes only.

Country	
Location	
Name of the company	

12% CONTINUE

1. What is the size of your company?

- ○ Micro – employs less than 10 employees and its annual turnover does not exceed 2 million euros;
- ○ Small or Medium – employs less than 250 employees and its annual turnover does not exceed 50 million euros;
- ○ Large - employs more than 250 employees and its annual turnover exceeds 50 million euros;

18% CONTINUE

2. When was your company established?

- ○ x ≤ 2 year
- ○ 2 < x ≥ 5 years
- ○ 5 < x ≥ 10 years
- ○ x > 10 years

24% CONTINUE

3. What is the geographical scope of your business?

- ○ Local
- ○ National
- ○ International, including these countries:

29% CONTINUE

4. Please choose your scope (multiple choices possible)

- ☐ Electronical devices;
- ☐ Materials for electronical devices;
- ☐ Materials for protection from electromagnetic field;
- ☐ Parts, components and/or pieces for electronical devices;
- ☐ Computing, ICT technologies, research and development;
- ☐ Other:

35% CONTINUE

5. Do you use laboratory testing services to test your production?

- ○ No
- ○ Yes - optional (please, write the institution's name)

41% CONTINUE

6. Do you know if there is any testing services to test your production in your region?

- ○ No
- ○ Yes (please, write the institution's name)

47% CONTINUE

Interreg Baltic Sea Region
TEST-4-SME - Mapping Testing services in Baltic Sea Region

7. Level of availability of testing infrastructure in your region

Please identify the level of availability of needed testing infrastructure for your company. Please choose not interested, if this type of testing is not relevant for your needs.

	Complete shortage	Poor availability	Adequate availability	Good availability	Very good availability	Not interested in this type of testing
Climatic testing	○	○	○	○	○	○
Electromagnetic Compatibility testing	○	○	○	○	○	○
Material & compositional characterization, testing & analysis	○	○	○	○	○	○
Electroconductivity/resistivity of materials	○	○	○	○	○	○
Manufacturing processes verification	○	○	○	○	○	○
Characterisation & testing of batteries, solar cells & electrical systems	○	○	○	○	○	○
Sound characterisation	○	○	○	○	○	○
Temperature & humidity environmental testing	○	○	○	○	○	○
Mechanical & structural characterisation & testing	○	○	○	○	○	○
Spectral responsivity of radiometric sensors	○	○	○	○	○	○
Calibration, characterization & measurements optical systems	○	○	○	○	○	○
Bioelectromagnetic testing (on live cells and model organisms)	○	○	○	○	○	○
Shock & vibration testing	○	○	○	○	○	○
Energy efficiency testing	○	○	○	○	○	○
Something else, please specify:	○	○	○	○	○	○

53% CONTINUE

Interreg Baltic Sea Region
TEST-4-SME - Mapping Testing services in Baltic Sea Region

8. Level of accessibility of testing services in your region

Please identify the level of accessibility of testing services for your company. Please choose not interested, if this type of testing is not relevant for your needs.

	Very low accessibility	Low accessibility	Adequate accessibility	Good accessibility	Very good accessibility	Not interested in this type of testing
Climatic testing	○	○	○	○	○	○
Electromagnetic Compatibility testing	○	○	○	○	○	○
Material & compositional characterization, testing & analysis	○	○	○	○	○	○
Electroconductivity/resistivity of materials	○	○	○	○	○	○
Manufacturing processes verification	○	○	○	○	○	○
Characterisation & testing of batteries, solar cells & electrical systems	○	○	○	○	○	○
Sound characterisation	○	○	○	○	○	○
Temperature & humidity environmental testing	○	○	○	○	○	○
Mechanical & structural characterisation & testing	○	○	○	○	○	○
Spectral responsivity of radiometric sensors	○	○	○	○	○	○
Calibration, characterization & measurements optical systems	○	○	○	○	○	○
Bioelectromagnetic testing (on live cells and model organisms)	○	○	○	○	○	○
Shock & vibration testing	○	○	○	○	○	○
Energy efficiency testing	○	○	○	○	○	○
Something else, please specify:	○	○	○	○	○	○

59% CONTINUE

9. Please identify which testing infrastructure is partly or completely missing in the reasonable proximity of your company

65% CONTINUE

10. Please specify the reasons of low availability of testing infrastructure in your region

- ☐ Lack of companies which need the testing services;
- ☐ Lack of highly qualified specialists who could perform the testing;
- ☐ Others (please, specify)

71% CONTINUE

11. Please specify the reasons of low accessibility to the required testing services in your region

- ☐ High costs;
- ☐ High utilisation rate of the required testing infrastructure, long waiting timing;
- ☐ Low awareness of the utilisation rules / frames of the available infrastructure;
- ☐ Restricted or limited accessibility imposed by owner of the required testing infrastructure;
- ☐ Others (please, specify)

76% CONTINUE

12. Please name the standards to which your products should meet in order to receive Certificate of Conformity

82% CONTINUE

13. Please name the Institutions whose services you are using for final testing to get the Certificate of Conformity and to put the Product on the market.

88% CONTINUE

Thank you for taking the time to fill out this questionnaire, we really appreciate your efforts!

TEST-4-SME team

94% CONTINUE

Source. Authors' illustration and compilation

Appendix B: Online survey – English version (print version)

1 Standard page

Dear participant

This research is being done to initiate an innovation support network with a shared knowledge in the BSR to provide testing for electronics SMEs to comply with the international standards during the early product development stage, which helps avoiding costly failures in later stages. TEST-4-SME works with members located in the BSR and seven pilot SMEs to test the network's services. The aim is to provide an expertise advise, and train staff in a wide range of testing methods to comfort standards needed by electronic producers.

The aim of the survey "Mapping Testing Services in Baltic Sea Region" is to identify and analyse the gaps, e.g. technical expertise or lack of hardware, in testing services as well as clarify SMEs' needs for electronic product or devices testing services in the region.

The survey will be completed by the company based on experience, knowledge, quantitative and qualitative data about the company. Minimum data about the company is collected in order to analyze the needs of different types of enterprises. The provided data will be treated confidentially and will be used for research and scientific purposes only.

This consent form asks you to allow the researcher to record and use your comments to enhance understanding of the topic. The form also asks your permission to use related observations & posts as data in this study. Participation in this study is completely voluntary. If you decide not to participate there will not be any negative consequences. Please be aware that if you decide to participate, you may stop participating at any time and you may decide not to answer any specific question.

The researcher will maintain the confidentiality of the research records or data, and all data will be achieved in order to make them available for other developments in line with current European Union Data sharing act. By agreeing on this form you are indicating that you have read the description of the study, and that you agree to the terms as described.

Thank you in advance for agreeing to participate in this survey.

TEST-4-SME team

2 Standard page

Mapping Testing Services in Baltic Sea Region

Please fill out the survey based on your current knowledge and experience in the field. The provided data will be treated confidentially and will be used for research and scientific purposes only.

Country	
Location	
Name of the company	

3 Standard page

1. What is the size of your company?

- ○ Micro – employs less than 10 employees and its annual turnover does not exceed 2 million euros;
- ○ Small or Medium – employs less than 250 employees and its annual turnover does not exceed 50 million euros;
- ○ Large - employs more than 250 employees and its annual turnover exceeds 50 million euros;

4 Standard page

2. When was your company established?

- ○ x ≤ 2 year
- ○ 2 < x ≥ 5 years
- ○ 5 < x ≥ 10 years
- ○ x > 10 years

5 Standard page

3. What is the geographical scope of your business?

- ○ Local
- ○ National
- ○ International, including these countries:

6 Standard page

4. Please choose your scope (multiple choices possible)

- ☐ Electronical devices;
- ☐ Materials for electronical devices;
- ☐ Materials for protection from electromagnetic field;
- ☐ Parts, components and/or pieces for electronical devices;
- ☐ Computing, ICT technologies, research and development;
- ☐ Other:

7 Standard page

5. Do you use laboratory testing services to test your production?

- ○ No
- ○ Yes - optional (please, write the institution's name)

8 Standard page

6. Do you know if there is any testing services to test your production in your region?

- ○ No
- ○ Yes (please, write the institution's name)

9 Standard page

7. Level of availability of testing infrastructure in your region

Please identify the level of availability of needed testing infrastructure for your company. Please choose not interested, if this type of testing is not relevant for your needs.

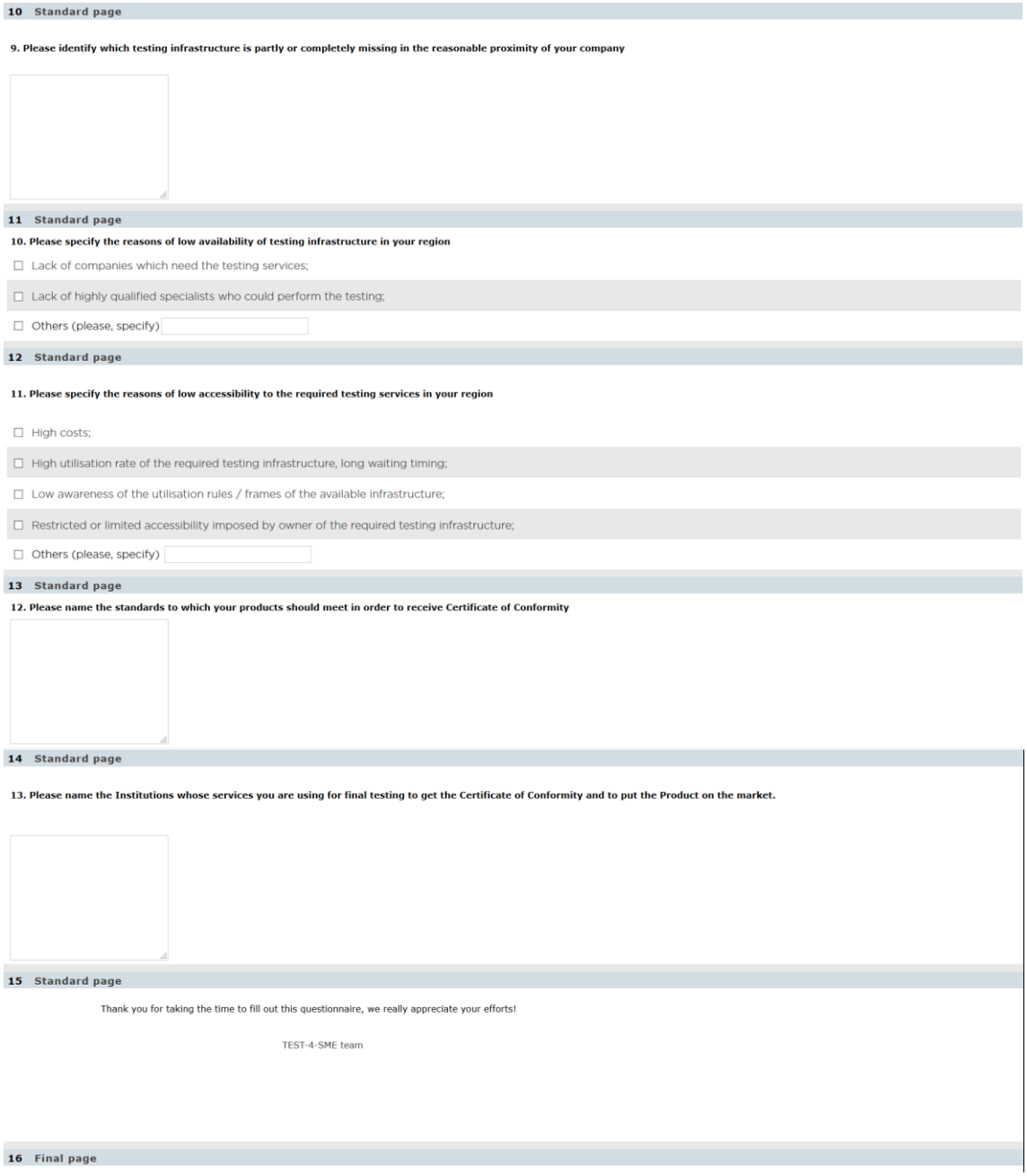
	Complete shortage	Poor availability	Adequate availability	Good availability	Very good availability	Not interested in this type of testing
Climatic testing	○	○	○	○	○	○
Electromagnetic Compatibility testing	○	○	○	○	○	○
Material & compositional characterization, testing & analysis	○	○	○	○	○	○
Electroconductivity/resistivity of materials	○	○	○	○	○	○
Manufacturing processes verification	○	○	○	○	○	○
Characterisation & testing of batteries, solar cells & electrical systems	○	○	○	○	○	○
Sound characterisation	○	○	○	○	○	○
Temperature & humidity environmental testing	○	○	○	○	○	○
Mechanical & structural characterisation & testing	○	○	○	○	○	○
Spectral responsivity of radiometric sensors	○	○	○	○	○	○
Calibration, characterization & measurements optical systems	○	○	○	○	○	○
Bioelectromagnetic testing (on live cells and model organisms)	○	○	○	○	○	○
Shock & vibration testing	○	○	○	○	○	○
Energy efficiency testing	○	○	○	○	○	○
Something else, please specify:	○	○	○	○	○	○

9.1 Standard page

8. Level of accessibility of testing services in your region

Please identify the level of accessibility of testing services for your company. Please choose not interested, if this type of testing is not relevant for your needs.

	Very low accessibility	Low accessibility	Adequate accessibility	Good accessibility	Very good accessibility	Not interested in this type of testing
Climatic testing	○	○	○	○	○	○
Electromagnetic Compatibility testing	○	○	○	○	○	○
Material & compositional characterization, testing & analysis	○	○	○	○	○	○
Electroconductivity/resistivity of materials	○	○	○	○	○	○
Manufacturing processes verification	○	○	○	○	○	○
Characterisation & testing of batteries, solar cells & electrical systems	○	○	○	○	○	○
Sound characterisation	○	○	○	○	○	○
Temperature & humidity environmental testing	○	○	○	○	○	○
Mechanical & structural characterisation & testing	○	○	○	○	○	○
Spectral responsivity of radiometric sensors	○	○	○	○	○	○
Calibration, characterization & measurements optical systems	○	○	○	○	○	○
Bioelectromagnetic testing (on live cells and model organisms)	○	○	○	○	○	○
Shock & vibration testing	○	○	○	○	○	○
Energy efficiency testing	○	○	○	○	○	○
Something else, please specify:	○	○	○	○	○	○



10 Standard page

9. Please identify which testing infrastructure is partly or completely missing in the reasonable proximity of your company

11 Standard page

10. Please specify the reasons of low availability of testing infrastructure in your region

- ☐ Lack of companies which need the testing services;
- ☐ Lack of highly qualified specialists who could perform the testing;
- ☐ Others (please, specify)

12 Standard page

11. Please specify the reasons of low accessibility to the required testing services in your region

- ☐ High costs;
- ☐ High utilisation rate of the required testing infrastructure, long waiting timing;
- ☐ Low awareness of the utilisation rules / frames of the available infrastructure;
- ☐ Restricted or limited accessibility imposed by owner of the required testing infrastructure;
- ☐ Others (please, specify)

13 Standard page

12. Please name the standards to which your products should meet in order to receive Certificate of Conformity

14 Standard page

13. Please name the Institutions whose services you are using for final testing to get the Certificate of Conformity and to put the Product on the market.

15 Standard page

Thank you for taking the time to fill out this questionnaire, we really appreciate your efforts!

TEST-4-SME team

16 Final page

Source. Authors' illustration and compilation

Appendix C: Geographical scope of business – international (raw data)

	Estonia	Latvia	Lithuania	Finland	Germany
Other international markets	North America, EU USA, Germany, Finland, Latvia EU, USA USA, Germany, Japan, Finland, Latvia, Estonia USA, Great Britain, France Finland Estonia, Sweden, Great Britain, USA, Mecca, Brazil, China … Finland USA, Great Britain, France Factory in Estonia, Finland, worldwide distribution Worldwide India Slovakia, Switzerland, China, Finland Eesit, Finland, China USA, Germany, Japan, Finland, Latvia, Estonia Latvia, Lithuania, Russia, Ukraine over 10 countries Estonia, Latvia EU, USA Product components manufactured in Asia, Estonia USA, Germany, Finland, Latvia	Lithuania, Estonia most known Italy, Germany EU, USA, China EU, etc. Lithuania, Estonia, Netherlands, Palestine, Ghana, Senegal, Saudi Arabia USA, Canada, EEA EU, USA, Russia, Belarus, Ukraine, India	European Union states, USA Germany, France Denmark, Germany, Austria and others Latvia, Russia, Estonia, Italy, Georgia Worldwide (China, USA, Korea, Australia, Russia, etc.) Holland, Norway, America, Russia, Belarus. Lithuania, Georgia, Mali, Holland Japan, Germany, France, Switzerland	Worldwide Europe, Asia, America Asia (etc. Japan, Singapore), Europe, USA, EMEA Global Europe Belgium Sweden, Norwey, Poland, China Europe, China China, USA, Germany Globally Finland, Germany, USA headquarters in US 17 countries global	worldwide whole EU Worldwide Russia, Sweden, Norway, Finland whole English-speaking world Sweden, Denmark worldwide, wherever AirLines fly

Source. Authors' illustration and compilation

Appendix D: Business activity fields – other (raw data)

	Estonia	Latvia	Lithuania	Finland	Germany
Other business activity fields	Dragonfly table lamp with electronics IoT Product Development Robotic vehicles Unmanned systems Unmanned systems Cable assemblies training Robotic vehicles medical technology laboratory equipment Product Development Measuring equipment	Programming of electronic devices Computer peripherals	Process control and automation PV *(author's note: photovoltaics)* installation of solar power plants Research and experimental development on natural sciences and engineering (Pulse laser research and production, Holographic systems, production of holographic printers, etc.) Solar modules, solar power plants Laser micro-nano-forming technologies	electronics integrated into moulded structures Health technology HPAC industry electronical control systems for mobile machinery laser optics measurement devices for process industry (pulp and paper, food, chemical) solar thermal collectors cables and wiring systems	Flight seats, flight technology service Micro pumps robotics IT and software Heat pumps, heating systems technical components, electronic drive technology Installation of electronic equipment, proper repair, operation, maintenance, network operation

Source. Authors' illustration and compilation

Appendix E: Usage of testing services for production – institutions (content analysis)

	BSR		Estonia		Latvia		Lithuania		Finland		Germany	
Usage of testing services for production - institutions	**hi**	**fi (in %)**	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)
Inspecta	**9**	**11,392**	7	38,889	0	0,000	2	11,765	0	0,000	0	0,000
Verkotan	**2**	**2,532**	2	11,111	0	0,000	0	0,000	0	0,000	0	0,000
Cetecom	**3**	**3,797**	2	11,111	1	6,667	0	0,000	0	0,000	0	0,000
RISE (RI.SE)	**3**	**3,797**	2	11,111	0	0,000	0	0,000	1	4,000	0	0,000
Tartu Obs	**2**	**2,532**	2	11,111	0	0,000	0	0,000	0	0,000	0	0,000
LEITC	**7**	**8,861**	2	11,111	5	33,333	0	0,000	0	0,000	0	0,000
Tõravere measuring laboratory	**1**	**1,266**	1	5,556	0	0,000	0	0,000	0	0,000	0	0,000
RODGER Labs	**1**	**1,266**	0	0,000	1	6,667	0	0,000	0	0,000	0	0,000
TÜV	**4**	**5,063**	0	0,000	2	13,333	2	11,765	0	0,000	0	0,000
TestLab	**1**	**1,266**	0	0,000	1	6,667	0	0,000	0	0,000	0	0,000
ORS	**1**	**1,266**	0	0,000	1	6,667	0	0,000	0	0,000	0	0,000
TRAD	**1**	**1,266**	0	0,000	1	6,667	0	0,000	0	0,000	0	0,000
Alter Technology	**1**	**1,266**	0	0,000	1	6,667	0	0,000	0	0,000	0	0,000
CFI	**1**	**1,266**	0	0,000	1	6,667	0	0,000	0	0,000	0	0,000
Dekra	**2**	**2,532**	0	0,000	1	6,667	0	0,000	0	0,000	1	25,000
Protech	**5**	**6,329**	0	0,000	0	0,000	5	29,412	0	0,000	0	0,000
Lithuanian Energy Institute	**1**	**1,266**	0	0,000	0	0,000	1	5,882	0	0,000	0	0,000
Kaunas Metrology Center	**1**	**1,266**	0	0,000	0	0,000	1	5,882	0	0,000	0	0,000
Vilnius Metrology Center	**2**	**2,532**	0	0,000	0	0,000	2	11,765	0	0,000	0	0,000
Communications Regulatory Authority (LT)	**1**	**1,266**	0	0,000	0	0,000	1	5,882	0	0,000	0	0,000
VU Laser Technology Center	**1**	**1,266**	0	0,000	0	0,000	1	5,882	0	0,000	0	0,000
FTMC	**2**	**2,532**	0	0,000	0	0,000	2	11,765	0	0,000	0	0,000
Centria	**6**	**7,595**	0	0,000	0	0,000	0	0,000	6	24,000	0	0,000
3K	**1**	**1,266**	0	0,000	0	0,000	0	0,000	1	4,000	0	0,000
Technobotnia	**1**	**1,266**	0	0,000	0	0,000	0	0,000	1	4,000	0	0,000
SGS Fimko	**2**	**2,532**	0	0,000	0	0,000	0	0,000	2	8,000	0	0,000
Etteplan	**4**	**5,063**	0	0,000	0	0,000	0	0,000	4	16,000	0	0,000
Eleforss	**1**	**1,266**	0	0,000	0	0,000	0	0,000	1	4,000	0	0,000
Enko	**1**	**1,266**	0	0,000	0	0,000	0	0,000	1	4,000	0	0,000
pro EMV	**1**	**1,266**	0	0,000	0	0,000	0	0,000	1	4,000	0	0,000
RST Rail System	**1**	**1,266**	0	0,000	0	0,000	0	0,000	1	4,000	0	0,000
G4C (Grant4COM)	**3**	**3,797**	0	0,000	0	0,000	0	0,000	3	12,000	0	0,000
Delta	**1**	**1,266**	0	0,000	0	0,000	0	0,000	1	4,000	0	0,000
Turku University of Appliend Scinces	**1**	**1,266**	0	0,000	0	0,000	0	0,000	1	4,000	0	0,000
ESJU	**1**	**1,266**	0	0,000	0	0,000	0	0,000	1	4,000	0	0,000
EMC laboratories	**1**	**1,266**	0	0,000	0	0,000	0	0,000	0	0,000	1	25,000
University of Wismar	**1**	**1,266**	0	0,000	0	0,000	0	0,000	0	0,000	1	25,000
DTC (Switzerland)	**1**	**1,266**	0	0,000	0	0,000	0	0,000	0	0,000	1	25,000
Total	***79***	***100,000***	*18*	*100,000*	*15*	*100,000*	*17*	*100,000*	*25*	*100,000*	*4*	*100,000*

Source. Authors' illustration and compilation

Appendix F: Usage of testing services for production – institutions (raw data)

	Estonia	Latvia	Lithuania	Finland	Germany
Usage of testing services for production – institutions	Inspecta Inspecta and others VERKOTAN Inspecta, Cetecom RISE Too few LEITC; Tartu Obs headquartered in the US, so most testing out there We have our own small laboratory but we are looking for a partner KIWA RISE the customer tests the devices themselves University of Tartu Observatory Inspecta Inspecta, Cetecom is currently in the development phase Tõravere measuring laboratory Verkotan Inspecta and others	LEITC Riga Technical University LEITC, RODGER Labs, TUF, CITECOM TUV Nordic, LEITC (RTU) LEITC, TestLab ORS, TRAD, Alter Technology, CFI, LEITC DEKRA	Protech Institute for Prospective Technology Applied Research Lithuanian Energy Institute and Kaunas Metrology Center Vilnius Metrology Center Prospective Technology Applied Research Institute, KIW, TUV Rheinland Prospective Technology Applied Research Institute Vilnius Metrology Center, TUV Rheinland GMbh, Kiwa, Protech Communications Regulatory Authority of the Republic of Lithuania FTMC VU Laser Technology Center, Center for Physical and Technological Sciences (FTMC)	Centria, 3K, own laboratories customers own laboratories Technobotnia, Centria, SGS, Etteplan Several different, varies Centria, Eleforss, Enko, pro EMV, RST Rail System, Etteplan Centria, G4C Centria, Ettplan, Delta Centria, Grant4Com, Etteplan Several different Grant4COM, ESJU, RI.SE Turku University of Appliend Scinces and SGS Fimko	EMC laboratories, Dekra University of Wismar DTC (Switzerland)

Source. Authors' illustration and compilation

Appendix G: Awareness of testing services in own region – institutions (content analysis)

	BSR		Estonia		Latvia		Lithuania		Finland		Germany	
Awareness of testing services in own region - institutions	**hi**	**fi (in %)**	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)	hi	fi (in %)
Inspecta	**7**	**8,140**	7	21,875	0	0,000	0	0,000	0	0,000	0	0,000
TalTech (TUT)	**8**	**9,302**	8	25,000	0	0,000	0	0,000	0	0,000	0	0,000
EMC laboratories	**3**	**3,488**	3	9,375	0	0,000	0	0,000	0	0,000	0	0,000
Tartu Obs	**5**	**5,814**	5	15,625	0	0,000	0	0,000	0	0,000	0	0,000
RISE (RI.SE)	**1**	**1,163**	1	3,125	0	0,000	0	0,000	0	0,000	0	0,000
Rantelon	**1**	**1,163**	1	3,125	0	0,000	0	0,000	0	0,000	0	0,000
LEITC	**8**	**9,302**	1	3,125	7	50,000	0	0,000	0	0,000	0	0,000
Cetecom	**1**	**1,163**	1	3,125	0	0,000	0	0,000	0	0,000	0	0,000
Tõravere measuring laboratory	**3**	**3,488**	3	9,375	0	0,000	0	0,000	0	0,000	0	0,000
University of Tallinn	**2**	**2,326**	2	6,250	0	0,000	0	0,000	0	0,000	0	0,000
TÜV	**4**	**4,651**	0	0,000	4	28,571	0	0,000	0	0,000	0	0,000
CFI	**1**	**1,163**	0	0,000	1	7,143	0	0,000	0	0,000	0	0,000
LNMC	**1**	**1,163**	0	0,000	1	7,143	0	0,000	0	0,000	0	0,000
BRC	**1**	**1,163**	0	0,000	1	7,143	0	0,000	0	0,000	0	0,000
Lithuanian Energy Institute	**1**	**1,163**	0	0,000	0	0,000	1	8,333	0	0,000	0	0,000
Kaunas Metrology Center	**1**	**1,163**	0	0,000	0	0,000	1	8,333	0	0,000	0	0,000
Vilnius Metrology Center	**2**	**2,326**	0	0,000	0	0,000	2	16,667	0	0,000	0	0,000
Protech	**3**	**3,488**	0	0,000	0	0,000	3	25,000	0	0,000	0	0,000
FTMC	**1**	**1,163**	0	0,000	0	0,000	1	8,333	0	0,000	0	0,000
VGTU	**1**	**1,163**	0	0,000	0	0,000	1	8,333	0	0,000	0	0,000
RRT	**1**	**1,163**	0	0,000	0	0,000	1	8,333	0	0,000	0	0,000
Latvian Electronic Equipment Testing Center	**1**	**1,163**	0	0,000	0	0,000	1	8,333	0	0,000	0	0,000
LIDARIS	**1**	**1,163**	0	0,000	0	0,000	1	8,333	0	0,000	0	0,000
Centria	**5**	**5,814**	0	0,000	0	0,000	0	0,000	5	26,316	0	0,000
3K	**1**	**1,163**	0	0,000	0	0,000	0	0,000	1	5,263	0	0,000
Technobotnia	**1**	**1,163**	0	0,000	0	0,000	0	0,000	1	5,263	0	0,000
SGS Fimko	**3**	**3,488**	0	0,000	0	0,000	0	0,000	3	15,789	0	0,000
Etteplan	**3**	**3,488**	0	0,000	0	0,000	0	0,000	3	15,789	0	0,000
G4C (Grant4COM)	**3**	**3,488**	0	0,000	0	0,000	0	0,000	3	15,789	0	0,000
Delta	**1**	**1,163**	0	0,000	0	0,000	0	0,000	1	5,263	0	0,000
Turku University of Appliend Scinces	**1**	**1,163**	0	0,000	0	0,000	0	0,000	1	5,263	0	0,000
ESJU	**1**	**1,163**	0	0,000	0	0,000	0	0,000	1	5,263	0	0,000
CEcert	**2**	**2,326**	0	0,000	0	0,000	0	0,000	0	0,000	2	22,222
University of Wismar	**4**	**4,651**	0	0,000	0	0,000	0	0,000	0	0,000	4	44,444
Fraunhofer	**2**	**2,326**	0	0,000	0	0,000	0	0,000	0	0,000	2	22,222
University of Rostock	**1**	**1,163**	0	0,000	0	0,000	0	0,000	0	0,000	1	11,111
Total	***86***	***100,000***	*32*	*100,000*	*14*	*100,000*	*12*	*100,000*	*19*	*100,000*	*9*	*100,000*

Source. Authors' illustration and compilation

Appendix H: Awareness of testing services in own region – institutions (raw data)

	Estonia	Latvia	Lithuania	Finland	Germany
Awareness of testing services in own region – institutions	Inspecta, TUT Inspecta TUT laboratories Inspecta Rauma EMClab Tartu Observatory, TUT Tartu Observatory RISE TALTECH TalTech; Rantelon Inspecta Estonia OÜ TUT, LEITC former CETECOM, Germany; Latvia Internal lab Everything is right near Finland Helsinki Tartu University Observatory Tartu Observatory, TUT Rauma EMC lab. Inspecta Tõravere Observatory Laboratory Tõravere Laboratories of UT Institute of Physics TUT laboratories Inspecta Inspecta, TUT TO Tõravere, UT Rauma EMC lab	LEITC and some others Riga Technical University LEITC, TUV, others LEITC, TUF Leitc TUV Nordic, LEITC (RTU) CFI LEITC, LNMC, TUV NORD BRC	Lithuanian Energy Institute and Kaunas Metrology Center Vilnius Metrology Center Prospective Technology Applied Research Institute Prospective Technology Applied Research Institute Vilnius Metrology Center, Protech FTMC, VGTU RRT Latvian Electronic Equipment Testing Center Optical Structure Resistance: UAB “LIDARIS”	Centria, 3K Technobotnia, Centria, SGS, Etteplan Centria, G4C Centria, Ettplan, Delta Everything is not available in Finland Centria, Grant4Com, Etteplan Several different Turku University of Appliend Scinces and SGS Fimko Grant4Com, ESJU, SGS Fimko Do not know / can't say	CEcert in Wismar University of Wismar University of Wismar Frauenhofer IGP no information Frauenhofer Institute University of Wismar University of Wismar CE-Cert GmbH University of Rostock

Source. Authors’ illustration and compilation

Appendix I: Reasons for low availability (multiple answer options) – other (raw data)

	Estonia	Latvia	Lithuania	Finland	Germany
Reasons for low availability of testing infrastructure in own region (multiple answer options)	Low customer interest Not easy to find who exactly tests Legislation in Creation Our products have been tested by the customer	Lack of competent expert advice / assessment	The available measurement equipment is not adapted to the next generation of solar cells and modules. Nearest infrastructure available in Germany. There are no accredited bodies capable of performing optical and temperature measurements. The level of suitability of testing infrastructure is not low for our company. You can choose from several companies.	Only few Accredited Laboratories Customers own Laboratories	Politically, these tests are not wanted High costs Niche application Historical development No test institutes specializing in aviation technology and loads

Source. Authors' illustration and compilation

Appendix J: Reasons for low accessibility (multiple answer options) – other (raw data)

	Estonia	Latvia	Lithuania	Finland	Germany
Reasons for low accessibility to the required testing services in own region (multiple answer options)	There are no necessary equipment in Estonia Lack of information No experience There are not enough companies that need testing services Lack of information Lack of legislation There are no necessary equipment in Estonia	There are not enough companies that offer such services It should be known to testers, not to the users of these services	Too slow to respond to market needs, emerging technologies. Low demand (1 company) for this type of measurement. Accreditation under the new IEC standards since 2016 Availability is not bad, but the market is small (point a), so the level is low	Only few accredited laboratories Customers own laboratories Test are not available	Fixed costs

Source. Authors' illustration and compilation

Appendix K: Product standards in order to receive Certificate of Conformity (raw data)

	Estonia	Latvia	Lithuania	Finland	Germany
Standards in order to receive Certificate of Conformity	RoHS EN 55022 Mainly EN61000-7xx series, EN55011, EN55022, sometimes others EN55022, ISO 61000, EN 55011 MIL-STD-1275 EMC, LVD EMC; SAR EMC, SAR EMC, LVD IPC / WHMA 610 & 620 EN 61000-4-2 / 3/4/5 eMark EN50022, 024, 61000, 0155 CE, subscriber standards EMC MIL-STD-1275 EN5502, ISO 61000, EN 55011 ISO 13485 CE NPPA Mainly EN 6100-4-xx series, EN 55011, EN 55022 EN 55022	Required certificates for electronics part - IEC 60335 (USA, Canada) and IN 60335-1; EN 60335-2-6 (Europe, Asia). REACH EU Very different ETSI, FCC, and others Not approved in Europe, is the development process of the US SAE J2954 CE ETSI EN 300 220 IEC50160 EN 50470-3 EN 62052-31: 2016 EN 6231 1: 2008 EN 301 489-3 V2.1.1 EN 301 489-1 V2.1.1 ESCC 9000 EN60 .. EN 61347-2-11: 2001 EN 61347-1: 2015 EN 60598-1 EN 60598-2-1 EN 60598-2-2 EN 60598-2-3 EN 60598-2-5	CE, EN-54, IEC 61439-1: 2011 IEC61215 and IEC61730 IEC 61215: 2016, IEC61730: 2016 IEC 61215, IEC61730 CE en55032 CE certification CE marking IEC 60825	IEC 60384-1, IEC 60384-14 and related testing standards (ENEC, cULus, CQC) AEC-Q200 testing standard. EN 61000-6-2 EN 61000-6-3 UNECE 10.5 MIL-STD-461 ... ISO 25197 EN 50155 ml EMC, Climate test EN 61000-6-3; (CISPR 16-2-3, CISPR 16-2-1); EN 61000-6-2; (EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6); E/ECE Regulation No. 10, Revision 4 (2012); E/ECE Regulation No. 10, Revision 3 (2008); Cold IEC 60068-2-1 (2007-03); Dry heat IEC 60068-2-2 (2007-07); Damp heat cycling IEC 60068-2-30 (2005-08); Change of temperature IEC 60068-2-14 (2009-01); Shock test IEC 60068-2-27 (2008-02); Vibration, random IEC 60068-2-64 (2008-04); Free fall, IEC 60068-2-31; Salt spray test ISO 9227;Dust test for IP6X according to IEC 60529; Water test for IPX7 according to IEC 60529 Depends on the product and project, long list. IEC60601-1; ISO20957-1:2013; ISO20957-2:2005; IEC60601-1-6:2010; IEC60601-1-1:2000 ENEC; EN 55015:2013 / EN 61547:2009 / EN 61000-3-2:2014 / EN 61000-3-3:2013 / EN 61347-1:2015 / EN 61347-2-13:2014 / EN 62384:2006 / IEC 62386-102:2009 /IEC 62386-207:2009 E.g. MIL-STD-461F ISO 16750-2 ISO 16750-3 ISO 16750-4 EN 13309:2010 EN ISO 14982:2009 EMC ISO 13766:2006 ISO 9806, DIN EN 12975, AS/NZS 2712:2017, AS/NZS 2535.1:2007	There is no single standard EMC Directive, ISO9001 ISO ISO standards Different standards according to the application profile DIN / ISO regulations ISO FDA 21 CFR 1040-10, FDA 21 CFR 1040-11, DIN EN 60825-1 DIN regulations, EC VDE, BEAB, IEC, CE, DIN DIN, EN, ISO regulations different according to the requirement profile ISO different standards according to the requirement profile ISO ETSO-C127a depending on the order situation ISO

Source. Authors' illustration and compilation

Appendix L: Institutions whose services are used for final testing to get Certificate of Conformity and to put products on the market (raw data)

	Estonia	Latvia	Lithuania	Finland	Germany
Institutions used for final testing in order to receive Certificate of Conformity	To assess Inspecta compliance Inspecta Inspecta RISE Fimko, Underwriter Laboratories, (CSA - Canada) LEITC, BACL, BV KIWA RISE.se Inspecta Inspecta, Tallinn Brick Conformity assessment of Inspecta	LEITC AITEX LEITC used, TUV used Roger Labs, FCC, IC TUV Nordic, LEITC (RTU) TestLab, LEITC Alter Technology DEKRA DEKRA	TÜV Rheinland, Fraunhofer ISE, ISC-Konstanz UAB Bureau Veritas Lit Tuv Rheinland, KIWA TUV, Germany TUV Rheinland GMbh (Cologne) RRT Latvian Electronic Equipment Testing Center	IMQ, SEMKO SGS Fimko What ever can offer the required service/testing Several Centria and G4C SGS etteplan, delta Centria, Etteplan SGS Fimko SGS Fimko, Grant4Com, RI.SE Dekra SGS Fimko Oy SGS Finko Oy IEC SPF Swirzerland	Department of energy CEcert, Dekra University of Wismar University of Wismar different providers (mostly based on personal contacts) SGS partly Hochschule Wismar University of Wismar Cecert Dynamic Test Center

Source. Authors' illustration and compilation