

# Kondratiev's Waves, Big Data and Value Chain Mapping

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**Abstract**—The results of Multicenter Study “Third Wave” are described in the article. EMC Academic Alliance Russia & CIS has launched this study in 2015. The variant of morphological analysis of Text Big Data from the Internet was implemented. Simon Wardley's Value Chain Mapping was used for interpretation of study results, the scheme was modified. The capacity of Text Big Data Analytics for assessment of innovation development in the Baltic Sea Region is shown.

## I. INTRODUCTION

The Big Data Analytics Multicenter Study “Third Wave” has been named after Alvin Toffler's “Third Wave” concept about information era [1]. EMC Academic Alliance Russia & CIS has launched this study in 2015 as open volunteer project for students. EMC Academic Alliance provides innovative approach that named Virtualized Student Mobility (VSM) [2]. VSM includes some projects, one of them is Big Data Analytics study, which is the volunteer academic research and education cooperation in open mode.

Academic ad-hoc team of the study consists of teachers and students. Given the increasing market demand for Text Big Data Analytics it is important for students to acquire new skills in Big Data Analytics staying in their universities. In this study students have acquired the skills of Data Mining working with API (Application Programming Interface) service that provide Google and Yandex. Data Mining was implemented as High Performance Big Data Analytics (HPDA). Google and Yandex are considered as non-classical hybrid supercomputers with API access “as-a-Service”.

Using API access morphological matrix of several Keywords Phrases (KP) was collected, KP were counted in million, in conjunction with the countries names and year of publication or mention of the year in the text (2008 and 2015). Graphic data processing performed using Microsoft Excel.

Analyzing text arrays from the Internet we don't study the global society separately from the information environment, but we can make an assessment of global society reflection in information systems. The global Internet environment is some kind of global audience discussion about various processes. In this regard the identified KP patterns are not a direct indication to processes in society, economics and politics, but KP patterns

reflect the interest in various economics or politics processes. KP patterns reflect the society as a dynamic flexible system with adaptive spatiotemporal changes in the world.

In this article some KP patterns are presented in conjunction with the 7 countries names from Baltic Sea Region, that were included into study: Russia, Finland, Denmark, Germany, Sweden, Estonia, Lithuania (Fig. 1).



Fig. 1. Google map of Baltic Sea Region with an indication to chosen countries for study “Third Wave”

Following KP were selected for Data Mining from Google and Yandex: Computer; Cloud computing; Electric cars; Mobile phone; Drip irrigation; Gas supplies; Oil; Oil price; Nuclear power plant; Solar panel. The languages of KP are English and Russian (counted together). The results of the study were considered from the point of Value Chain Map, that has been presented by Simon Wardley at O'Reilly conference “Open Source Convention” [3; 4]. Value Chain Map was modified to be applied to analyze the results of Text Big Data Analytics in this study (Fig. 2).

## II. THE NEW TECHNOLOGICAL ORDER

The chosen KP for Data Mining in this study (Fig. 3; Fig. 4) reflect the main modern economic trends.

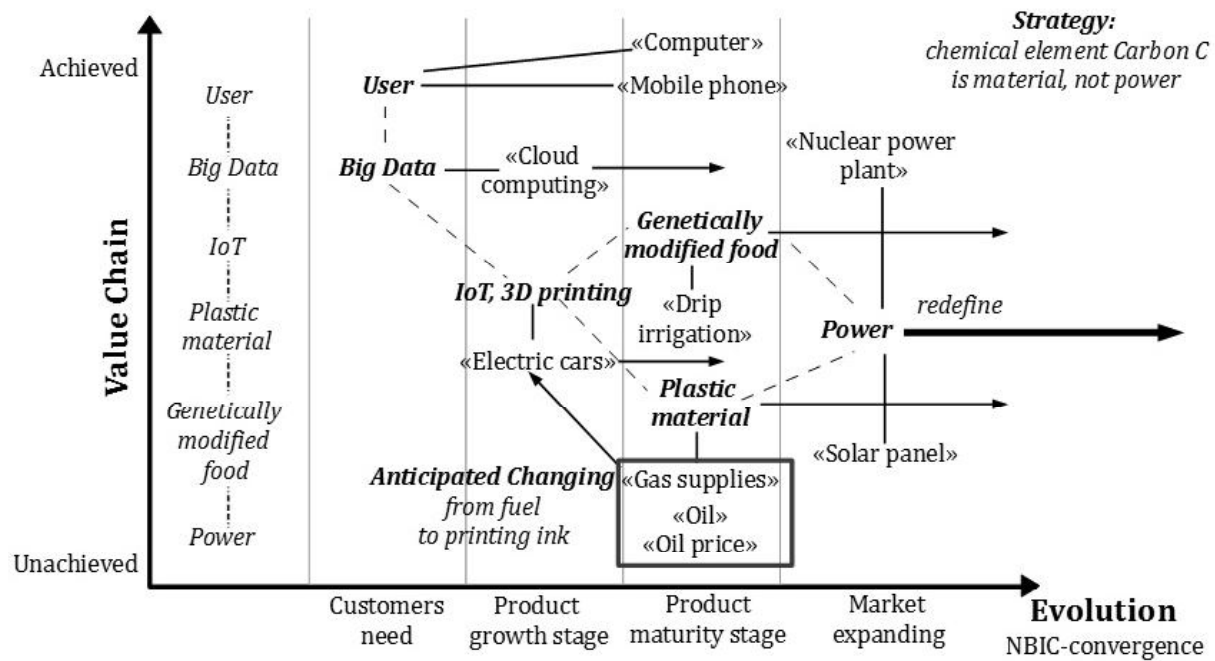


Fig. 2. The modified Value Chain Map for results of Text Big Data Analytics in study "Third Wave". All the components of the Value Chain Map are evolving from left to right due to demand competition

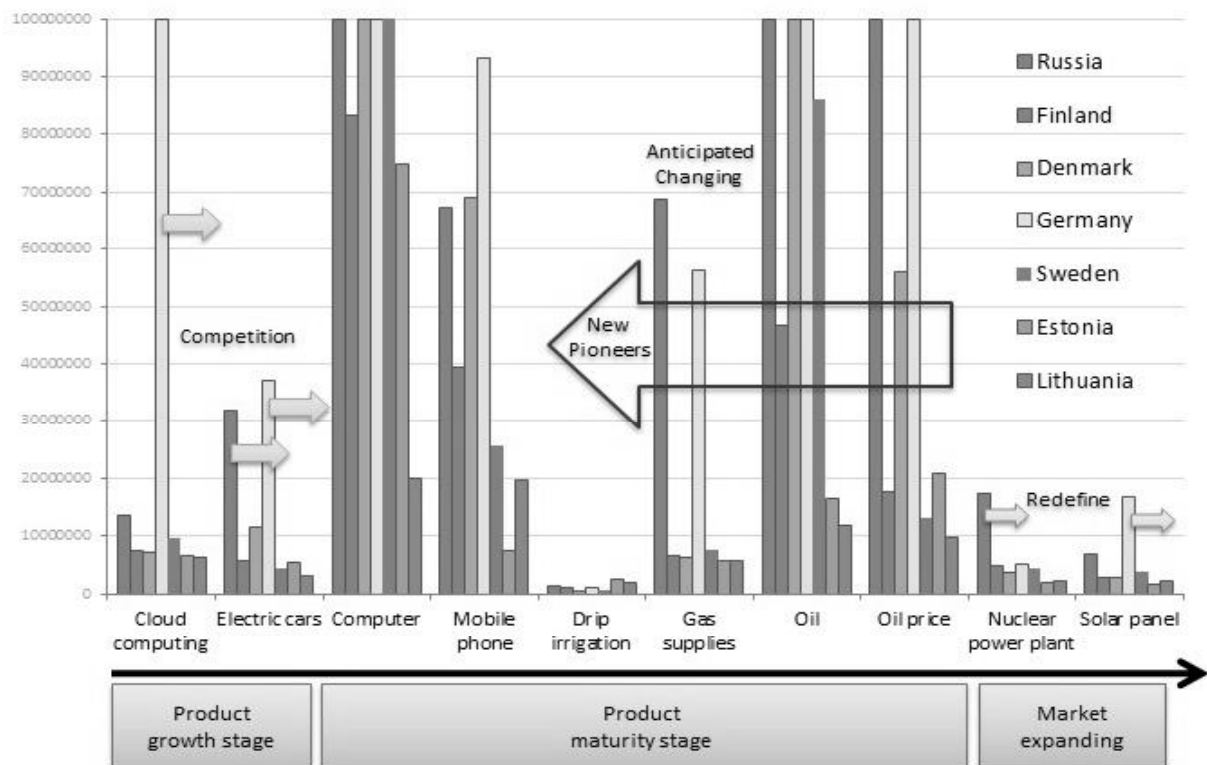


Fig. 3. The number of Keywords Phrases in million during 2015 in conjunction with the countries names. Level above 100 million isn't shown

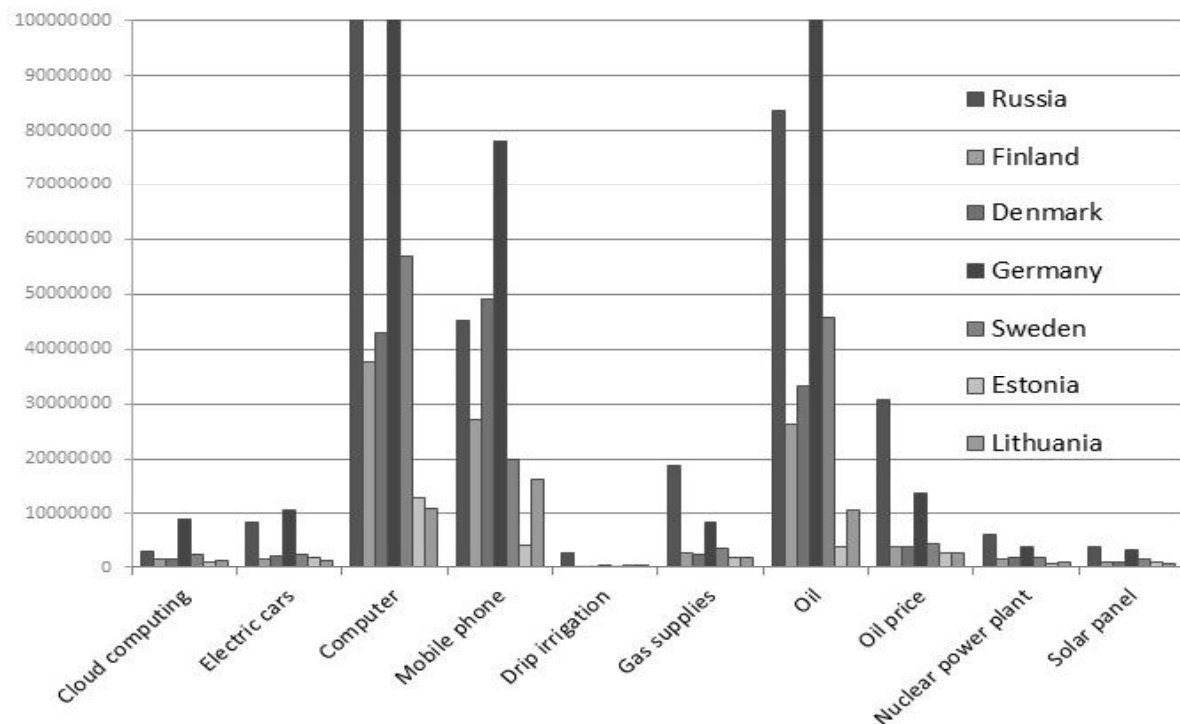


Fig. 4. The number of Keywords Phrases in million during 2008 in conjunction with the countries names. Level above 100 million isn't shown

1) “Computer”. This keyword has the highest frequency among all ten chosen KP. This fact indicates the change in technological order to IT. Computer era has begun since the Cybernetic revolution (the beginning from period 1940-1980), that is considered as the start of Third Toffler's Wave [1]. The first wave had been agricultural, the economy had been based on land. The second wave has been industrial, economy has been dependent on industry and hydrocarbon energy. Today weak countries are still living in conditions of the second industrial wave. Third wave is modern time and the future, the economy is linked to information technology and globalization. Another measure of the evolution of technological order are Kondratiev's waves [5]. These waves aren't so common during history as Toffler proposed his three-waves concept. Kondratiev's waves endure 30-50 years, they have two phases – positive and negative. Start of Cybernetic revolution had coincided with the fourth Kondratiev's wave (1947-1991). The KP “Computer” is the sign of fourth Kondratiev's wave. Today this wave is completely finished and we can see a clear dominance of this sign in the study as widely distributed products. On diagrams (Fig. 3; Fig. 4) can be noticed the increase of number KP “Computer” from 2008 to 2015. During both years this KP dominated.

2) “Mobile phone”. This KP also indicates the change in technological order to IT. Mobile phone can be attributed to the period of the fifth Kondratiev's wave (1991-2020). Only in the last decade mobile phones have become widespread in the world as distributed products. On diagram (Fig. 3) we can see the high level of this KP number for countries with large economy as Russia and Germany, and also the high level of

this KP number was detected for Finland. This fact addresses to Nokia – the Finnish multinational communications and information technology company that is the one of big vendors of mobile phones in the world. During fifth Kondratiev's wave the main features of IT era have appeared: the growth of information volume; minimization of devices size; mass use of plastic materials. These main features are the most associated with mobile phones.

3) “Cloud computing”. The concept of Cloud computing has appeared since 2006. Cloud computing has caused the explosive growth of data volume. Since 2008 concept of Big Data has appeared due to Clifford Lynch. Internet of Things (IoT) as the concept has been described in 1999 by Kevin Ashton from Massachusetts Institute of Technology. But only when Cloud computing has appeared the IoT got the real impetus to evolution [6; 7; 8; 9]. Today Cloud computing cannot yet be called as distributed products, it is still looking for ways of development and places at the market. Cloud computing is the sign of upcoming sixth Kondratiev's wave (2020-2070), during this wave will be completing of Cybernetic revolution. After sixth Kondratiev's wave scientists suggest the emergence of a whole new era for global society – era of Transhumanism (abbreviated as H+), which aims to transform the human due to sophisticated technologies to enhance intellectual, physical, and psychological capacities [10]. But today the way to H+ goes through Cloud computing, Big Data, IoT, NBIC with robotics and Artificial Intelligence. The ecosystem of IoT is based on numerous devices including mobile phones (cloud-related services for mobile operators). IoT is the Cloud computing network of devices, vehicles,

buildings and other items which are embedded with electronics, software, sensors. Most of these devices due to Cloud computing will be easy created by 3D-printing from plastic materials and also will include nanotechnology [11; 12; 13; 14; 15; 16; 17]. As we can see on diagrams (Fig. 3; Fig. 4) there is one strong leader Germany among 7 presented countries of Baltic Sea Region. This Germany's breakaway has occurred after 2008. Certainly it can be concluded that Germany will be ahead among other countries in the region in terms of achieving the widely distributed market of Cloud computing, that will ensure Germany economic leadership in the upcoming sixth Kondratiev's wave.

4) *"Electric cars"*. This KP reflects the interest in crucial technology that has already brought down the oil market. In other words, the electric cars are the real turning point in technological order. Just return to history. The first Kondratiev's wave (1803-1843) had been associated with the industrial processing of coal; the second Kondratiev's wave (1844-1896) had been related with ferrous metallurgy and railways; the third Kondratiev's wave (1896-1947) had been the raise of heavy machinery, electricity, steel and electric motors for industries (mechanical engineering, woodworking and other). Electric motors have appeared since invention by the British scientist Michael Faraday in 1821, and after Moritz Hermann von Jacobi in Russia in 1834 invented the usable electric motor, and Nikola Tesla in USA in 1888 sold his patents of electric motor. The fourth Kondratiev's wave (1947-1991) wasn't only start of Cybernetic revolution, but also it was the period of oil and gas production and internal combustion engine for vehicles. We can mention the idea of the Russian scientist Dmitriy Mendeleev (in report to Russian government in 1886 "Baku oil business") that to burn oil is the same as to stoke stove by banknotes. Mendeleev was the first who proposed to build the factories for petrochemical industry. Today not only automobiles are changing to electric motors but airplanes too. In 2013 the European aerospace concern EADS with Rolls-Royce presented at Le Bourget the new project of creating hybrid airplane with electric motor. Bloomberg predicted a further downturn of oil price due to the electric cars growing market (Tesla Motors, Chevrolet Ford, Volkswagen, Nissan, BMW, Apple, Google). The most interesting trend is the emergence of 3D-printing technology for production of electric cars [15]. Local Motors created the electric car LM3D and Divergent Microfactories created the electric car Blade – the 3D-printing material for these cars are carbon fibre composite tubes. This means that oil and gas are no longer needed as fuel for new cars, but they are very needed as oil and gas chemistry products for 3D-printing of cars. The process of 3D-printing is based on Cloud computing [11; 12; 13]. More Cloud computing will expand, more 3D-printing cars will be at the market. Electric cars need the electricity grid (Supercharger network), that more and more involve IoT, including household electricity [13]. Common electricity grid is the inducement of transition to electric cars, because it allows to Big Data Analytics for cost savings. Common electricity grid is based on Cloud computing. As a result we have the dependency: more Cloud computing, more

common electricity grid, more electric cars, more 3D-printing, more needed oil and gas chemistry products as material for cars 3D-printing. As we can see on diagrams (Fig. 3; Fig. 4) Russia and Germany have increased interest in electric cars, that is the sign of future presence both countries at this market.

In the study "Third Wave" we analyzed results of Text Big Data Analytics for 49 countries (data about 49 countries are presented on the site [18]). The new dependency between Cloud computing and gas supplies was detected only for 3 countries: USA, United Kingdom and Germany. It has appeared after 2008 (Fig. 5; Fig. 6).

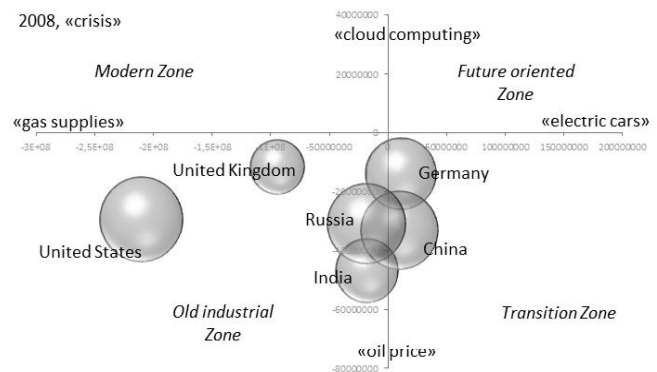


Fig. 5. The number of Keywords Phrases in million during 2008 in conjunction with the countries names. Axis X: plus – the number of KP "electric cars"; minus – the number of KP "gas supplies; location of circles was chosen by dominance in the pair of KP. Axis Y: plus – the number of KP "Cloud computing"; minus – the number of KP "Oil price; location of circles was chosen by dominance in the pair of KP. The size of circles is the number of KP "crisis" in million

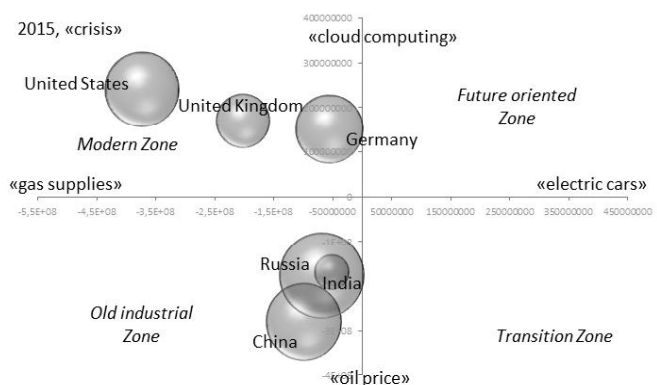


Fig. 6. The number of Keywords Phrases in million during 2015 in conjunction with the countries names. Axis X: plus – the number of KP "electric cars"; minus – the number of KP "gas supplies; location of circles was chosen by dominance in the pair of KP. Axis Y: plus – the number of KP "Cloud computing"; minus – the number of KP "Oil price; location of circles was chosen by dominance in the pair of KP. The size of circles is the number of KP "crisis" in million

5) *"Gas supplies"; "Oil"; "Oil price"*. In terms of mentioned above upcoming sixth Kondratiev's wave (2020-2070) the hydrocarbons will change the function from fuel to something as can be called "printing ink" for 3D-printing mass consumption products, including cars. Hydrocarbons or carbon

[illegible]

This Kohonen map shows the big clusters: sport, medicine, mathematics, computing, science, biology (the dark grey zones). These clusters reflect the global society interest in these topics, as a whole together this is the theme of improving the human body and its capacity. It is the clear sign of global interest in Transhumanism. Humankind is on the way to H+ that means the growing demand of synthetic carbon materials connected to Cloud computing. On diagrams (Fig. 3; Fig. 4) is shown the very high level of KP “Gas supplies”; “Oil”; “Oil price” for Russia, Germany, Finland, Denmark and Sweden. On the whole among 49 countries, that were included into the study “Third Wave”, high level of KP “Gas supplies” was found for 16 countries (Fig. 8). These countries would be

**Gas supplies**

16 Ukraine  
15 Russia  
14 China  
13 Turkey  
12 Malaysia  
11 South Korea  
10 Georgia  
9 Japan  
8 Germany  
7 United Kingdom  
6 United States  
5 Canada  
4 Australia  
3 New Zealand  
2 Singapore  
1 India

6) “*Drip irrigation*”. This KP reflect the some important trends. Sensors of the drip irrigation systems at the fields create the Big Data (electronic fields) and agricultural IoT, that will lead to new economic value and efficiency. Adequate water supply is topical problem in terms of Global warming for regions with growing population in Africa and Asia as well as for rest of the world. Drip irrigation is the mark of economic competitiveness in general and in the agricultural market in particular, defining food security. Also it reflect the technology involvement into agriculture, including genetically modified technology. On diagrams (Fig. 3; Fig. 4) is shown that common level of KP “Drip irrigation” is low for all countries that are presented. For more details we can look to the percentage ratio of countries interest in the each of ten KP (Fig. 9; Fig. 10). Is shown that especially Estonia and also Lithuania have the growing interest in drip irrigation. If we will look to different Internet media articles about Estonia’s agriculture, we can find that Estonia is the most successful and efficient country in Baltic Sea Region in terms of agriculture [21]. The average farm size in hectares in Estonia is four times more than in Lithuania. Thus KP “Drip irrigation” is the clear sign of real situation in modern agriculture.

511

10) can be mentioned that among presented countries Germany shows the growing interest in solar energy. The same we can see on diagrams above (Fig. 3; Fig. 4), Germany is the leader in Baltic Sea Region. Looking to surface diagram (Fig. 11) can be mentioned that only Germany among presented countries shows the growing interest in two crucial trends of development: Cloud computing and solar energy. This fact reflect Germany's strategic focus on leadership at the new emerging technology market from key distributed computing technology to key technology of unlimited energy supply. It is important to notice another outlook about future. First is the concept of global sustainable development such as Venus Project of Jacque Fresco, in that solar energy is the basic technology. And second is the space exploration that has already used solar energy. Especially as the energy dependence long stay in space should be mentioned the future digging of Lunar regolith for mining Titanium and Helium-3.

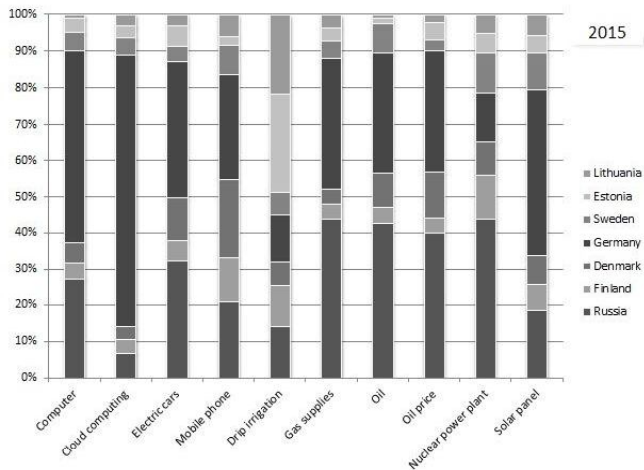


Fig. 9. The percentage ratio of countries interest in the each of ten Keywords Phrases during 2015

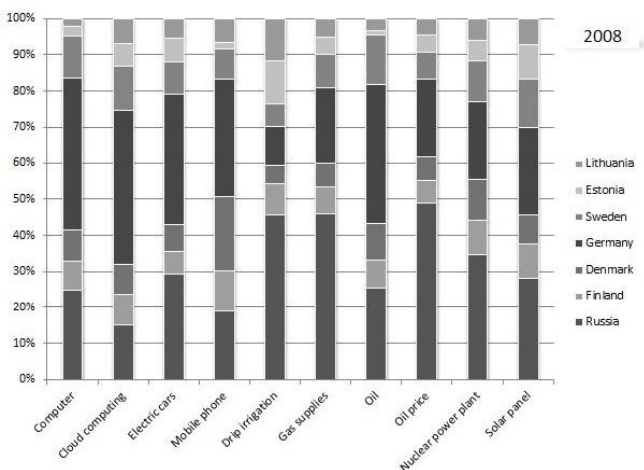


Fig. 10. The percentage ratio of countries interest in the each of ten Keywords Phrases during 2008

8) “Nuclear power plant”. This KP reflect the traditional for Russia energy type. The diagrams (Fig. 3; Fig. 4; Fig. 9; Fig. 10) show the Russia growing interest in nuclear power.

Russia has such technology as floating (shipping) nuclear power stations, that also can be used for ocean water desalination. Upcoming global market of nuclear power will be the miniature nuclear batteries for mass consumption [24].

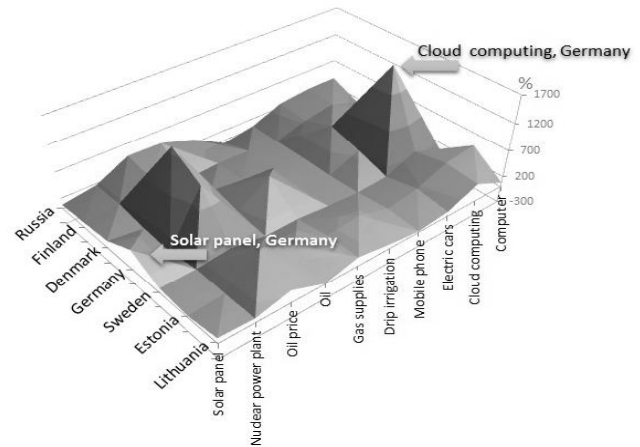


Fig. 11. The surface diagram of percentage increase of Keywords Phrases number for countries from 2008 to 2015

### III. VALUE CHAIN MAPPING

Text Big Data Analytics in this study has been used for analysis of unstructured texts in Internet in terms of assessment and forecasting the economic situation at the global market. We attempted to understand can the text component of Internet environment be analyzed by morphological approach? How unstructured text arrays, accumulated in the Internet from different sources and on various occasions, do correlate with classical statistical information and reality? Study “Third Wave” has endured second year and we published some articles about study findings. Results of the study showed that arrays of KP randomly created online by global audience reflect the real processes taking place in the global society. Dataficated arrays of KP correlate with classical statistical information related to the economic and social situation in countries. KP can be used for forecast assessment of countries.

Internet can be considered as an unstructured environment filled with words [25]. If people write, think and talk about something more or less, it has to have some reason. Words have become data that can be analyzed to obtain new knowledge and awareness about situation [26]. There are some successful examples of extraction practical benefits from Text Big Data Analytics – Google Flu project [27] and Google Books Ngram Viewer [28]. Text Big Data Analytics is one of the HPDA priorities because the main goal of HPDA is to create the algorithms for texts “understanding” and consequently creation of Artificial Intelligence [29]. The approaches to texts analysis can be very different. It is not simple to select right words for analytics. For example if we choose KP “apple color” and set the goal to discover what kind of apple color is the most frequent in Internet texts, the results may not be relevant to situation awareness. We can find the frequent KP “black” or “rainbow colors” because it is Apple Inc. logo.



Another problem is the method of analysis. In this case we used Simon Wardley's approach [3; 4] for assess the economic situation in terms of competitiveness and shaping the future consumer market. The proposed Wardley map was modified and were added Keywords Phrases from our study (Fig. 2). Making map we can look to Keywords Phrases data in dynamics. Value Chain Mapping allows to put Keywords Phrases in needed sequence to determine what is already cover previous stage of development, and what is the innovative stage that determines future success. Map helps to look to diagram (Fig. 3) not as static that shows more or less number of Keywords Phrases, but in dynamics, with understanding past and future processes. In sum we can see on Fig. 3 that Germany among presented countries of Baltic Sea Region has the great advantages. Germany has the predominant interest in Cloud computing that makes us expect in the future Germany leading at the market consumption and sales. Also Germany has predominant interest in solar energy that allows to expect in the future Germany strong and stable position during period of changing energy trends and increasing demand for energy. Data about Russia shows that among presented countries of Baltic Sea Region Russia (as well as Germany) may take a leading position at the market of electric vehicles – for example today Russia has LADA Ellada, LADA Vesta, LIAZ-6274. In the energy sector development Russia is traditionally focused on nuclear energy, that along with solar energy assures the advantages during increasing energy demand. Concerning the hydrocarbon sector alongside with withdrawal from the market petrol and internal combustion engines, will continue to grow plastics market for 3D-printing technology, including vehicles market. Based on data on Fig. 3 can be expected pioneers at this new market of 3D-printing materials – Russia, Germany, Finland, Denmark and Sweden in Baltic Sea Region; and global – USA, Canada, UK and other (see Fig. 8).

#### IV. CONCLUSION

Some outputs can be noted from this study.

A. Text Big Data Analytics with using API Google and API Yandex can be applied to the analysis of the economic situation at global market. But it should be mentioned that we can make only an assessment of global society and global economy reflection in information systems, and we cannot have direct indication to processes in society, economics and politics.

B. Based on the results of the study can be mentioned an advantage of Russia, Germany, Finland, Denmark and Sweden cooperation in the pioneer's direction of new 3D-printing materials elaboration.

C. This type of Text Big Data Analytics is the starting point of the wider study that should include all countries assessment, IP data about the number of Internet users, cluster analysis, correlation analysis. The understanding of different words frequency in the global Internet is an important scientific task that leads to connection of Artificial Intelligence with Internet for the rapid analysis of situation and forecast.

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