Functioning of the Local Production Systems in Central and Eastern European Countries and Siberia

Case Studies and Comparative Studies

Edited by
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Zbigniew Gontar[*]

PERSPECTIVES OF INTEGRATED "NEXT INDUSTRIAL REVOLUTION" CLUSTERS IN POLAND AND SIBERIA

1. Introduction

This study is concentrated on perspectives of the next industrial revolution clusters in Poland and Siberia. Next industrial revolution is a manifestation of Internet of Things, Data and Services (IoTDS) paradigm,[1] offering new ways of monitoring and managing all components of business, enables new types of products and services, and new strategies,[2] and enables developing new forms of industrial organizations. Stephan Haller from SAP research – a research unit of SAP AG – defines IoTDS as a world, where physical objects are seamlessly integrated into the information network, and where the physical objects can become active

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[1] M. Ruggieri, H. Nikookar, *Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems*, River Publishers, 2013.

[2] J. Manyika et al., *Disruptive technologies: Advances that will transform life, business, and the global economy*, McKinsey Global Institute Report, May 2013, McKinsey & Company, 2013.

participants in business processes, and services are available to interact with these smart objects over the Internet, query and change their state and any information associated with them, taking into account security and privacy issues.[3] The growing relevance, scale, and complexity of smart initiatives at the universities of the world (StreetScooter GmbH[4] at the University of Aachen, Transformative Learning Technologies Lab[5] at the Stanford University, City Science[6] and SENSEable City Laboratory[7] at MIT, etc.) entails the need to find the solutions for the coordination of its development, focused on innovation and entrepreneurship in order to strengthen regional economies. The following two steps are identified in the paper as necessary to establish trans-border next industrial revolution clusters: smart campus projects enhancing universities capability to establish smart industry projects,[8] and the trans-border centres of excellence for smart industry aimed at developing and implementation joint integrated network of international programmes in the field of smart industry and to establish a trans-border network of master courses concerning smart industry in which companies would also be involved, and strengthening cooperation between Poland and Siberia in the field of smart industry, involving the universities.

The new up-to-date paradigm driving next industrial revolution[9] is Integrated Industry, the lead theme and official motto for Hannover Messe 2014 – one of the world's most important trade fair for industrial technology – and the purpose of German government project Industry 4.0, one of the symbols of the next industrial revolution. In Harting's In-

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[3] S. Haller, *The Things in the Internet of Things*, [in:] *Proceedings of Internet of Things*, Conference 2010, Tokyo 2010.

[4] Access: www.streetscooter.eu

[5] Access: tltl.stanford.edu

[6] Access: cities.media.mit.edu

[7] Access: senseable.mit.edu

[8] Smart campus means that universities will be an experimental field for implementing smart initiatives.

[9] R. M. Locke, R. L. Wellhausen (eds.), *Production in the Innovation Economy. The MIT Task Force on Production and Innovation*, MIT, 2010.

tegrated Industry concept,[10] components, solutions, systems and consulting services are combined into an innovation range that covers all levels. Each single level is just as important as the interaction of all in order for us to act as competent partners for our customers.[11] Integrated Industry is not only a research concept, but currently industrial application, e.g. Festo company is currently working on the water project in St. Petersburg in the framework of Integrated Industry, and Intelligent Systems & Technologies Laboratory at the Institute of international educational programs, St. Petersburg state polytechnic university equipped with Integrated Industry equipment.[12] In general, Integrated Industry means integration of engineering distributed facilities with intelligent system enabling on-line control and optimization of these facilities.[13] It enables in the near future the construction of distributed power plants and factories, composed with many levels located in manufacturing or energy pools in the future smart cities. Reindustrialization in that sense means establishing the areas of such pools or the areas of production and control pools. The specific smart industry initiatives mentioned above are aimed at establishing next industrial revolution industry clusters in the sense of new organization of industrial companies resembling integrated industry concept: distributed virtual cross-board company,[14] with digitally developing and manufacturing products and systems, offering new ways of cooperation through Internet networking, and optimizing its processes split among thousands of participants and distributed Poland and Siberia wide, equipped with intelligent networked manufacturing systems supported by embedded software, operating on products containing software, GPS systems, sensors and actuators, testing on a digital model the product, the production system, the tooling and manufacturing facility, and characterizing by the integration of the value creation

[10] Access: www.harting.com

[11] Philip Harting, Board Member for Connectivity & Networks at HARTING.

[12] Access: www.festo.com, www.festo-didactic.com

[13] Monitor, Magazine for electrical safety, 1/2013.

[14] B. Gontar, Z. Gontar, *A Cross-Border Innovation Cluster Assessment Methodology*, Social Science, Kaunas University of Technology, 2013, p. 7–14.

chain in the sense of involving potential future customers in the concept and planning phases (involved in innovation and product development) forcing integration the data from the sketch through to the ordering of spare parts.[15]

The estimated period of full implementation of next industrial revolution policy is 6-20 years. At the moment, the core of the next industrial revolution seems to be the integration of the organizations, the processes, the specialist disciplines and the entire value creation chain (or other value creation logic). This integration could be enhanced by trans-border initiatives. The next industrial revolution industry clusters proposed in the paper are exemplification of this idea. This enables stronger engagement of Poland and Siberia in next industrial revolution development.

Value/originality of the paper is as follows: list of artefacts associated with next industrial revolution, new concept of industry clusters, map of potential next revolution initiatives in Poland and Siberia, and the idea of smart organization. The accelerated development of science and technology determinates continuous change in external conditions and revise the rules of performance of enterprises. From the point of view of the next industrial revolution, the most important determinants include smart manufacturing, saturated by intelligent information and communication technologies (ICT), and new technologies which allow to change any consumer in the manufacturing prosumer. The differences between big manufacturers and manufacturing prosumers will then disappear, as each of them will use shared resources from manufacturing pools, and large manufacturers will be balanced by grid manufacturing clusters (in a similar way grid computing competes now with supercomputers in the sense of computing power). For this to happen, it is needed the implementation of smart education ideas. Smart organization shall be understood as grid enterprise (e.g. trans-border organization), microgrid enterprise (e.g. reduced to the geographic area), and smart compact enterprise (e.g. smart organization reduced to the factory, like the SmartFactory KL project).

[15] U. Sendler, *Integrated Industry – big idea, but it covers a lot*, Monitor 1/2013, p. 4–8.

2. Method for identification next industrial revolution clusters

The paper explores the concepts of the next industrial revolution, and smart-manufacturing hubs[16] projects as perspectives of integrated industry clusters. The goal of the research is to identify common features of the next industrial revolution, and define a roadmap for implementation of the next industrial revolution concept in Poland and Siberia.

The objectives of the article are as follows:

1. To review and discuss the concepts of the next industrial revolution,
2. To identify best practices concerning the next industrial revolution,
3. To define roadmap of developing perspectives of digital cross-border innovation clusters between Siberia and Poland.

The researches consisted of five following phases:

1. Creating a list of Integrated Industry initiatives to survey,
2. Collecting data and creating artefacts of Integrated Industry initiatives,
3. Perform an in-depth analysis of the collected data,
4. Identifying perspectives of Integrated Industry initiatives mapping in Poland and Siberia,
5. Define roadmap of developing perspectives of cross-border Integrated Industry clusters between Siberia and Poland.

Smart, sustainable and inclusive regional growth in the closed future will be based on ideas taken from the next industrial revolution. In smart era trans-border integrated industry clusters will take over many of the tasks carried out by traditional innovation instruments, offering new opportunities. The research of perspectives of trans-border integrated industry clusters are important from different points of view, also taking into account the development of the regions. This may contribute to the emergence of new regional policy instruments.

The results of the paper is the roadmap of developing the potential next industrial revolution industry clusters in Poland and Siberia. The clusters are discovered as the smart-manufacturing hubs dealing with the following initiatives:

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[16] Manufacturing hubs are defined in the paper as cooperation of industry, universities, governments, and other parties to solve innovation deployment challenges of smart industry.

1. FabLabs originated in Neil Gershenfeld student course at Massachusetts Institute of Technology, US[17] entitled “How to Make (Almost) Anything”. While the first projects were rather insignificant (bag for screams, etc.), at the moment due to technology development (3D printers, 3D scanners, Computerized Numerical Control machine tools, etc.) and open-source hardware movement, it is a global environment coordinated by Fab foundation evolving toward establishing factories at home.[18] From the perspective of next industrial revolution industry clusters, FabLabs are a tool aimed at establishing innovate and educational workplace for cross-border initiatives in the sense of factories at home pools coordinated by regional competency centers. It is planned in the next two years more than 20 labs for personalized digital production will be set up in Moscow and its surroundings, and another over 100 across Russia.

2. Fabless manufacturing (personal manufacturing) aimed at creation manufacturing pools concentrating on performing production work, integrated with manufacturing centres equipped with enterprise manufacturing integration and intelligence systems enabling operating in those flexible manufacturing structure. The flag project of that concept: StreetScooter established at the University of Aachem, Germany indicates the direction of future evolution of this idea. In Siberia, in 2009 Rusnano, Russia’s largest nanotech company, and the Nitol, international group of investors started its Usolye Sibirsky Silicon (USS) to produce polysilicon (poly-Si) material for solar energy and microelectronics, and established Liotech, company in Siberia’s Novosibirsk manufacturing lithium-ion storage batteries, Novosibirsk and Tomsk for the nano centres. The most prominent fab-less design Russian enterprises for military are MCST, Elvees and Module.

3. Smart Factory understood in the sense of the first European Smart Factory, built originally in Kaiserslautern in 2007, Germany as a Cyber-Physical System by the German Research Center for Artificial In-

[17] N. Gershenfeld, *Fab: The Coming Revolution on Your Desktop–from Personal Computers to Personal Fabrication*, Basic Books, 2005.

[18] H. Lipson, M. Kurman, *Factory@Home: The emerging economy of personal fabrication*, White House Office of Science and Technology Policy, 2010.

telligence (DFKI) with 20 industrial and research partners, having equivalents in the form of Smart Manufacturing initiative in US[19] engaging the leading US universities, and deployed as a concept in Germany Industry 4.0 initiative integrating government, university and industry. From the perspective of next industrial revolution industry clusters it is a manufacturing grid of fully automated production. Software Engineering Company “Smart Solutions” is only one of Russian SME which has won the FP7 Integrated Project (IP) in Consortium with EADS, Airbus and world-leading universities, consulting companies and software vendors.

4. Smart Materials are resemble to smart manufacturing or smart grid systems, in the sense that they automatically adjust their properties according to external environment. In the paper, we consider smart materials only in the framework of biotechnology, and this type of potential next industrial revolution industry clusters will be regarded as smart biotechnology clusters.

3. Next industrial revolution

The next industrial revolution is considered in the paper mainly as a manifestation of Internet of Things, Data and Services (IoTDS). According to Mazhelis et al.,[20] IoTDS could be described from the following four perspectives:

1. MIT Auto-ID Labs[21] perspective referring to things or virtual entities identification in the form of Radio-frequency identification (RFID)

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[19] J. Davis, T. Edgar, J. Porter-DuPont, J. Bernaden, M. S. Sarli, *Smart Manufacturing, Manufacturing Intelligence And Demand-Dynamic Performance*, “Computers & Chemical Engineering” 2012, Vol. 47, p. 145–156.

[20] O. Mazhelis, H. Warma, S. Leminen, P. Ahokangas, P. Pussinen, M. Rajahonka, R. Siuruainen, H. Okkonen, A. Shveykovskiy, J. Myllykoski, *Internet of Things Market, Value Networks, and Business Models: State of the art Report*, Jyväskylä University Printing House, Jyväskylä 2013.

[21] The Auto-ID Labs are the leading global research network of academic laboratories in the field of Internet of Things, access: www.autoidlabs.org

tags or Electronic Product Code (EPC). From this perspective, IoTDS is a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols.[22]

2. Web of Things community[23] et al., referring to the Internet architecture. From this perspective, IoTDS is a global network infrastructure, linking physical and virtual objects through the exploitation of data capture and communication capabilities on the base of specific object-identification, sensor and connection capability as the basis for the development of independent cooperative services and applications, with high degree of autonomous data capture, event transfer, network connectivity and interoperability (EU founded project: Coordination and support action for global RFID-related activities and standardisation – CASAGRAS).

3. Semantic technologies perspective, referring to representation, organization and storage, searching and exchanging the things-generated information. From this perspective, IoTDS is an interoperability among IoTDS resources, information models, data providers and consumers, and facilitates effective data access and integration, resource discovery, semantic reasoning, and knowledge extraction on the base of efficient methods and solutions that can structure, annotate, share and make sense of the IoT data and facilitate transforming it to actionable knowledge and intelligence in different application domains.[24]

4. We add one more perspective to this list, i.e. business process analysis perspective, referring to SOA architecture, and process mining analysis.[25] From this perspective, IoTDS is a dynamical network of highly dispersed processes, whose choreography and orchestration are defined on the base of online analysis of processes through process mining extension of Bosh attempts to combine Business Process Management (BPM), Business Rules Management (BRM) and Machine to Machine Communication (M2M) into

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[22] EPoSS – The European Technology Platform on Smart Systems Integration, access: www.smart-systems-integration.org

[23] Access: www.webofthings.org

[24] P. Barnaghi, W. Wang, C. Henson, K. Taylo, *Semantics for the Internet of Things: early progress and back to the future*, "International Journal on Semantic Web and Information" 2013, Vol. 8, p. 1–21.

[25] B. Gontar, Z. Gontar, *Business Process Mining*, Ekonomika i Organizacja Przedsiębiorstwa, Instytut Organizacji i Zarządzania w Przemyśle „ORGMASZ", 2013, p. 18–27.

IoTDS implementations.[26] According to Smith I.G. (ed.),[27] one of the current Internet of Things, Data and Services issues is business models, which means an exploitation of the IoTDS business potential, and new business models for the existing incumbents but also new and innovative players need to be developed. New business models for IoTDS reefer mainly to manufacturing, where it would be possible to plan and produce (almost) at the same time. The first attempts of manufacturing in this framework are very promising, i.e. so called Disruptive Network Approach (DNA) of StreetScooter manufacturer or SmartFactory KL project. Both projects are initialized by university environment: University of Aachen, and German Research Center for Artificial Intelligence (DFKI). Process Mining, called also Automated Business Process Discovery, Process Intelligence, Process Analysis or Workflow Mining integrates Business Process Management (BPM), Data Warehousing (DW) and Business Intelligence (BI), and includes methods, standards and tools to support the discovery and analysis of operational business processes. Process mining is an approach that provides new and objective insights into the way business processes are conducted within organizations. Taking a set of real executions (event logs) as the starting point, these techniques attempt to extract useful process information from various perspectives.

The next industrial revolution is characterized by:

– intensive use of information and communication technologies, including 3D printers, 3D scanners, Computerized Numerical Control machine tools, Cyber-Physical Systems, multi-agent systems, SOA, business intelligence, open hardware,

– real time monitoring and analysis, based on new business intelligence applications, i.e. Manufacturing Intelligence, Smart Grid Analytics, etc.,

– two way communication between producer and consumer, and as result active customer participation in production and domination of prosumers, which concept is the combination of two words – producers and consumers, what in extreme form means personal manufacturing, just like described in Fab Lab concept,

– distributed production with the control of dispersed automated business processes based on production pools,

[26] Access: www.bosch-si.com

[27] I. G. Smith, *The Internet of Things*, ClusterBook, New Horizons, 2012.

– smart meters enabling online business processes control,
– new players and new services enabling creation of new business leader,
– smart materials enabling biotechnology applications in all fields.

The most influential concepts of the next industrial revolution are Neil Gershenfeld's Fab Labs from 2002, enabling personal digital manufacturing,[28] and creation of new business ecosystem through the following stages: building effective forms of collective action and self-organisation for Fab Labs, breaking free from traditional systems of manufacturing and creating value and creatively design new systems that tap into the capabilities of Fab Labs, protection of the interests and creative freedom of makers ensuring wide access to new knowledge, processes and products, appropriately and effectively creation and capturing value, achieving equity and fairness.[29]

Table 1. Artefacts of industrial revolutions

1st	2nd	The next industrial revolution
1	2	3
Printing Press / Information Network	Radio, TV / Media Network	Internet and its evolution into the cloud / Digital media network
Coal and Steam	Oil and Electricity	Silicon and Computer
Mass education	Combustion engine	Internet of Energy[a] / Renewable Energies
Railways and Rail transport	Highways	Internet of things, data and services[b] (IoTDS) / Web of Things (WoT) / Machine to Machine (M2M)
Factories	New materials	Smart Materials / Smart Everything / Smart Factory[c] / Decentralized Production / Agile Manufacturing / Automatic identification and data capture (AIDC)[d]

[28] N. Gershenfeld, *Fab: The Coming Revolution on Your Desktop--from Personal Computers to Personal Fabrication*, Basic Books, 2005.

[29] P. Troxler, *Making the 3rd Industrial Revolution. The struggle for Polycentric Structures and a New Peer-Production Commons in the Fab Lab Community*, J. Walter-Hermann & C. Buching (eds.), FabLab: Of Machines, Makers and Inventions, Bielefield, Transcript Publishers, 2013.

1	2	3
Seaports and ship transport	Automobiles	Cyber physical systems[e] (CPS) Semantic technologies
	Mass production	FabLabs / Persobal Manufacturing / Personal Fabricators / Personal Fabrication / Personal Computer Manufacturing
	Mass consumption	Open source hardware
		Prosumer era
		Manufacturing intelligence / Decentralized Intelligence[f] /
		Smart Factory / Automating manufacturing processes / Cloud manufacturing
		Manufacturing as Commodity[g]

[a] According to Germany Trade & Invest (access: www.gtai.de) this model is based on principles of smart power generation, smart power grids, smart storage, and smart consumption.

[b] This refers to a world in which all everyday objects, devices and services are completely interconnected for seamless interoperability. Ordinary objects, devices and services in the physical world will, for example, be able to independently communicate and exchange information over the internet thanks to increased programmability, memory storage capacity, and sensor-based capabilities.

[c] Smart factory refers to cyber-physical systems (accessed *op. cit.*).

[d] AIDC referred to as “Auto-ID” refers to the methods of automatically identifying objects, collecting data about them, and entering that data directly into computer systems (i.e. without human involvement).

[e] Cyber-physical systems (CPS) means embedded systems, enriched with internet, enabling online data and services processing.

[f] Decentralized intelligence means intelligent objects enabling via network connection independent process management.

[g] The concept from the 90-ies, assuming, that manufacturing system like a turnkey production network is highly adaptive because it uses turnkey relationships to weave various key production clusters into a global-scale production network based on external economics for OEMs and brand-owners.

Source: own study.

In Poland, there are a few Fab Labs projects, including FabLab Warszawa,[30] FabLab Kielce,[31] FabLab Łódź,[32] FabLab Trójmiasto.[33] In Siberia, similar project has been established or has been announced to be established in Krasnoyarsk,[34] Norilsk, Khabarovsk.

Another concept worth mentioning is a new form of manufacturing: pooled, digital and personal,[35] based on open source hardware and open design, resembling to those of the Open Hardware project, the Open Source Hardware and Design Alliance, et al. In such environment, manufacturing corporations will dramatically change, just like in the concept of Industrie 4.0 from 2011,[36] in which physical equipment of manufacturing environment is located in manufacturing pools with broadband Internet access, autonomously exchanging information, triggering actions, controlling each other, and visible for the enterprise as objects in the Internet cloud.[37] All these concepts indicate new industrial revolution in the sense of the end of fixed and predefined manufacturing structures, and as a consequence of this – triumph of distributed manufacturing in trans border business ecosystem across the whole digital value chain (or other value creation logic). Integrated industry clusters in that sense are production networks, dynamic, and self-coordinating established as a result of innovation policy in business ecosystems around smart cities, just like Novosibirsk and Ekaterinburg in Siberia, or Warszawa-Łódź duopolis or Silesian megapolis in Poland.

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[30] Access: fablab.waw.pl

[31] Access: www.fablabkielce.pl, www.tytan3d.com

[32] Access: fablablodz.org

[33] Access: www.fablabt.org

[34] Access: fablab24.ru

[35] C. Anderson, *Makers. The New Industrial Revolution*, Crown Publishing Group, New York 2012.

[36] G. Baum, H. Borcherding, M. Broy, M. Eigner, A. S. Huber, H. K. Kohler, S. Russwurm, M. Stümpfle, U. Sendler, *Industrie 4.0: Beherrschung der industriellen Komplexität mit SysLM*, Springer Vieweg, 2013.

[37] H. Kagermann, W. Wahlster, J. Helbig, *Recommendations for implementing the strategic initiative INDUSTRIE 4.0, Securing the future of German manufacturing industry*, Final report of the Industrie 4.0 Working Group, 2013.

4. Integrated industry characteristics

The main discussion on the subject of the next industrial revolution in the sense of Industry 4.0 is taking place on the Plattform Industrie 4.0[38] launched in 2013 by the industry associations in Germany: VDMA,[39] ZVEI[40] and BITKOM[41] with the aim to manage the implementation of Industry 4.0 concept.

In the paper, integration in manufacturing is defined fourfold:

– vertical integration of production and resources systems in networked manufacturing system, controlled by manufacturing intelligence systems,

– horizontal integration of production and resources systems through value networks controlled by manufacturing intelligence systems,

– integrated engineering throughout the product lifecycle, using product lifecycle management (PLM) systems,

– integration of information areas, meaning merging of machines and information into a system that is responsive and efficient in concurrent engineering.

As a result, separated production environments are combined to produce universal production worlds, which are partly of a physical, and partly of a cyber nature.

5. University engagement in new industrial revolution – results of the survey

There are at least the six outstanding lines of initiatives of the world concerning new industrial revolution, in which universities play key economic role: FabLab concept originated by the Massachusetts Institute

[38] Access: www.plattform-i40.de

[39] German Engineering Association (VDMA) access: www.vdma.org

[40] German Electrical and Electronic Manufacturers' Association (ZVEI) access: www.zvei.org

[41] German Association for Information Technology, Telecommunications and New Media (BITCOM) access: www.bitkom.org

of Technology, aimed at establishing manufacturing society, where majority of the jobs will be associated with personal manufacturing, Smart Manufacturing initiative in the US, concentrating on the Smart Manufacturing Leadership Coalition attempts to standardize the implementation of smart concept in industry and engaging the leading US universities, the Industrial Internet Concept by General Electric (GE) in the US being the result of engagement the biggest corporations in new forms of manufacturing, Industry 4.0 in Germany being the example of integration of government, university and industry initiatives, and smart grid – different forms of application of IoTDS to energy sector, and National Network for Manufacturing Innovation (NNMI) in the US aiming at building a network of regional manufacturing hubs with the leading role of the US universities, that will accelerate development of new manufacturing technologies.

The symbol of universities' engagement in new industrial revolution in Europe seems to be SmartFactoryKL in Kaiserslautern, Germany – a manufacturer-independent, model, demonstration and research platform, built in 2007 by the German Research Center for Artificial Intelligence (DFKI) with 20 industrial and research partners.[42] The vision of Smart Factory was developed in 2004. Non-profit association "Technology Initiative SmartFactory KL" was launched in 2005. SmartFactoryKL thus became the first European, supplier-neutral, demo-factory for the industrial application of modern information technologies. SmartFactoryKL is a real production system producing and bottling colored liquid soap, and the platform served as a research and development basis in numerous projects. The product is manufactured, filled into dispenser bottles, labeled, and delivered by consumer order. The plant has been designed modular and consist of a process manufacturing part, and a piece goods handling part.[43]

The business model for the university engagement in the next industry revolution encompass the following elements:

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[42] Access: www.smartfactory-kl.de

[43] D. Zuehlke, *Smart Factory – Towards a factory-of-things*, "Annual Reviews in Control" 2010, Vol. 34, Issue 1, p. 129–138.

– smart campus initiatives, enabling contact with up-to-date technologies, getting involved in developing required solutions, work on the theory related to smart era concept, cooperation with innovative industry,

– university engagement in smart city/smart grid/smart manufacturing initiatives, enabling integration with manufacturers, and non-profit organizations aiming at growing the capabilities in smart grid technology, 3D printing, reducing energy costs, etc. through collaboration in design, materials, technologies, etc.

– university engagement in establishing the next industrial revolution centers of excellence (innovation institutes), enabling managing all aspects of an next industrial revolution strategy, projects and systems, including developing, and implementing new innovative tools and supporting the users who rely on them.

The table 2 shows the results of a survey of the next industry revolution initiatives in Poland and Siberia.

All projects presented above are in the infancy stage, however indicate the potential of establishing a quality trans-border clusters enabling cooperation between Poland and Siberia in the area of smart grid, smart manufacturing, and new materials (biotechnology). Transformation of these projects into Integrated Industry Clusters in Poland And Siberia would be possible through institutional engagement for establishing facilities for dispersed initiatives. In Russia, similar initiatives covering cooperation with Germany are under way, including the Russian-German Center for Innovation and Entrepreneurship, the Russia – Germany Innovation Forum "Energy efficiency 2020: ideas, technology, services", German-Russian Innovation Forum "Promoting business process management excellence in Russia" Propeller 2012,[44] etc.

[44] Access: propeller.ercis.org

Table 2. Selected examples of next industry revolution initiatives in Poland and Siberia

Selected Initiatives	Poland	Siberia
1	2	3
Smart Campus initiatives: universities look like cities in the sense of public safety, transportation, energy and water management, building maintenance, student services, etc.[a]	1. Cracow AGH UST and General Electric (GE) agreement signed in October 17, 2012 on cooperation in development of Smart Grid concept, focused on building smart grid infrastructure for conducting research and development activities, and creation of (smart grid) Green AGH UST campus 2. Smart Campus initiative at Jagiellonian University, Cracow, Poland	3. Vladivostok FEFU project of Smart Campus, based on the information system for the university, including a bank card that also serves as student pass to the campus and its facilities, the online university services, and an intranet that consists of services and educational sections, designed to allow easy access to global collaborative events
Smart City initiatives: deployment of an urban IoT, i.e. a communication infrastructure that provides unified, simple, and economical access to a plethora of public services, thus unleashing potential synergies and increasing transparency to the citizens[b]	4. Smart City Congress[c], established by Smart IT Cluster[d], 5. IBM Executive Service Corps (ESC) project, established in 2010 by the City Hall of Katowice in cooperation with IBM with the aim of identification crucial problems in the City and the Silesia Metropolis and to prepare strategy for the city how to achieve sustainability goals, i.e. to become smarter (IBM Smarter City Challenge grant, 2010) 6. Łódź, (IBM Smarter City Challenge grant, 2013)	7. Building in Vladivostok the Complex Social Safety System 8. Tomsk 3.0 – Cognitive City of the Future 9. Yekaterinburg, the City of Ural

1	2	3
Energy of Things/Smart Grid /Intelligent Energy	10. AGH UST Centre of Energetics – a part of the European Institute of Innovation and Technology (EIT) 11. Green Energy Cluster[e].	12. Intellectual metering systems, owned by the Krasnoyarsk regional energy company, and with the support of the Russian energy agency and in close collaboration with France's Sagemcom established in Krasnoyarsk a plant manufacturing smart meters 13. FEFU in Vladivostok, Federal Hydro Company JSC RusHydro (Moscow) and machine-building company SchneiderElektrik (Rueil-Malmaison, France) project Energy efficient technologies and alternative energy, aimed in the creation of the Far Eastern Federal University research and education and world-class manufacturing center: implementation in the campus on Russkiy island scientific training, production and testing site. The complex energy management of FEFU campus facilities.
FabLab	14. Makerland[f] conference, Warsaw, 17–19th March 2014	15. FabLab Krasnoyarsk (fablab24.ru)
Fabless manufactcuring	16. Green Cars Cluster[g],	

Table 2 (cont.)

1	2	3
Internet of Things, Data and Services/Machine to Machine Communication (M2M)	17. According to ThingSpeak[h] Usage Stats, The Top 10 Internet of Things Countries are as follows: United States, France, Poland, United Kingdom, Germany, Netherlands, Australia, Canada, Italy, Brazil 18. Smart Home application, Arlamowski Investment[i] 19. 7th IEEE International Conference on Emerging Technologies & Factory Automation (ETFA 2012), Kraków, Poland, September 2012 20. Estimote start-up Project / Cracow[j]	
Smart Materials / Biotechnology	21. The Malopolska Centre of Biotechnology (MBC) by the Jagiellonian University[k], BioNanoPark in Lodz[l],	22. Biotechnopark in Koltsovo[m]

[a] J. Belissent, *Schools Move Beyond The Basics: Competition Will Drive Technology Into The Education Market*, Forrester Research, 2011.

[b] A. Zanella, L. Vangelista, *Internet of Things for Smart Cities*, "IEEE Internet Of Things Journal" 2014, Vol. 1, No. 1, p. 22–32.

[c] Access: smartpl.eu

[d] Access: it.greenpl.org

[e] Access: www.ge.greenpl.org

[f] Access: www.makerland.org

[g] Access: www.gc.greenpl.org

[h] Access: thingspeak.com

[i] Access: www.arlamowski.pl

[j] Access: www.facebook.com/estimote

[k] Access: www.mcb.uj.edu.p

[l] Access: www.technopark.lodz.pl

[m] Access: en.btp-nso.ru

Source: own study.

6. Discussion/Conclusions

The next industry revolution is a very popular concept in industrialized countries. The perspectives of next industrial revolution industry clusters means new organization of industrial companies, resembling integrated industry concept.

The model of integrated industry clusters assumes engagement of universities as determinants of strategy for establishing new smart enterprises. The next industrial revolution, associated mainly with Internet of Energy and smart manufacturing, rely on new achievements in ICT area, and development of the following two branches of Business Intelligence (BI), i.e. Smart Grid Analytics, and Manufacturing Intelligence. BI projects need special assistance, i.e. Business Intelligence Competency Center (BICC, in other words Center of Excellence),[45] which is a team of people that is responsible for managing all aspects of an organization's BI strategy, projects and systems, including developing a BI strategy, implementing BI tools and applications and then training and supporting the business users who rely on them.

The trans-border centers of excellence for smart industry would help in better understanding the potential benefits that the next industrial revolution initiatives can provide in business operations. The steps for setting up Integrated Industry Competency Center (IICC) are to be resembling those of BICC, i.e.:[46]

1. Understanding next industrial revolution concept and relevance to Poland and Siberia development. Conduct next industrial revolution concept assessment in the sense of economical potential. Perform gap analysis. Create roadmap and action plan,

2. Define IICC objective and mandate. Build case (e.g. Smart Factory). Decide on functional area to be addressed and required roles and skills. Develop change management plan,

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[45] BICC concept emerged in 2001, as results of researches conducted by Gartner Research (Dresner 2001).

[46] These phases to set up competency center are based on SAS proposition, access: www.sas.com

3. Assign roles to people. Train IICC stuff. Execute change management plan. Prepare work environment,

4. Run first project. Review project and IICC functions, and on the base of findings, create new projects.

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Abstract

The paper presents the mapping of potential next industrial revolution clusters in Poland and Siberia. Deindustrialization of the cities and struggles with its consequences are one of the fundamental economic problems in current global economy. Some hope to find an answer to that problem is associated with the idea of next industrial revolution and reindustrialization initiatives. In the paper, projects aimed at developing next industrial revolution clusters are analyzed. The objective of the research was to examine new industrial revolution paradigm as a platform for establishing university-based trans-border industry clusters in Poland and Siberia[47] and to raise awareness of next industry revolution initiatives.

Key words: clusters, new industrial revolution, case studies.

[47] Platform is both business model, and organizational design dedicated to business ecosystems in the next industrial revolution. Baldwin indicates the emergence of new organizational designs, i.e. open-communities, and standard-setting organizations (Baldwin, 2012).