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ACTION RESEARCH – A NEW APPROACH FOR ENVIRONMENTAL RD&I

Mirela Danubianu [1], Cristian Teodorescu[2]

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Abstract: High efficiency research, development and innovation (RD&I) constitute an answer to the ever growing importance that EU states give to knowledge-based development (a central idea in the Europe 2020 Strategy), directed toward finding comprehensive solutions to concerns connected to the Europe's resource depletion, energy future, climate changes, etc. The "Action Research" paradigm appeared in the late 1940s but its systematic application is the attribute of recent years. It keeps researchers in the real world, requires teamwork, collaboration with communities and other stakeholders. Action Research is especially suitable in projects for reducing anthropic footprint / environmental aggression and in waste management. In essence, Action Research (for the first time systematically applied in Romania) is the research approach that lets the problem studied to conduct the analysis and generate appropriate solutions; it constitutes a flexible, versatile technique to generate new knowledge through iterative interaction with the domain studied - namely the environment - researchers and communities.

The paper presents the application of Action Research in a Norwegian-financed, Industrial Symbiosis Project in Romania. Details of the Action Research as a tool for training young researchers are presented. Solutions generated during the application of Action Research dealt with the identification of new ways to turn waste into valuable resources, assessing the merits of multiple alternatives and picking up the optimal one form the triple bottom line (economic, environmental, social) characteristic to sustainable development.

The paper examines the issues of multi-disciplinary ways, how Action Research can be integrated into academic curricula, giving practical results which make it more accessible to students. When compared to the traditional way of training researchers and scientific research approach, Action Research is clearly a better approach, widening the horizon offered by accountability, improving the effectiveness and efficiency of knowledge generation processes.

[1] "Ştefan cel Mare" University-Suceava, mdanub@eed.usv.ro
[2] GEC-Bucovina, Suceava, christit@gmail.com

1. Presentation of action research

In a paper published in 1946, Kurt Lewin first suggested the "Action Research" term (Lewin, 1946), describing the content of this term as "a comparative research on the conditions and effects of various forms of social action and research leading to social action" by recurring to "a spiral of steps, each of which composed of a circle of planning, action, and fact-finding about the result of the action". The approach is essentially iterative and interactive, step-by-step, trial-and-error and it is sometimes referred to as the *Lewinian spiral*. It is very similar to the Deming Cycle: *Plan-Do-Check-Act* or *Plan-Do-Check-Adjust* (Bulsuk, 2009). After almost seven decades of development, the Action Research Paradigm (ARP) has expanded and evolved and has been applied to a vast variety of domains, starting with engineering research and ending in medicine, education and social applications (CCAR, 2014; ARNA, 2014). The current content of the ARP includes:

- RD&I activities initiated to solve a problem of stringent importance
- a process of stepwise problem solving using teamwork, usually led by experts but including members of many stakeholders (leading to a "community of practice") that could guide the RD&I process, tailor it to local characteristics and monitor and evaluate progress; stakeholders could be experts, members from the academic media, business companies, communities, NGOs, financing bodies, Regulating Agencies, local and central governmental bodies, etc.;
- an interactive process in which all stakeholders could participate and are kept fully informed, even they are not members of the RD&I team but could be directly affected by its work;
- a knowledge generation process taking its source from practice and practitioners;
- an atmosphere of positive tensions and "conflicts" occurring in research, development and innovation (RD&I) activities (Kuhn, 2000). These tensions are present among those led by the RD&I itself and those led by the subject studied, among those motivated by achieving targets and those motivated by personal, institutional and societal changes, among those interested in research for themselves, those interested in the scientific progress of the team and those interested in large scale societal changes potentially induced by RD&I:
- a continuous involvement of stakeholders in the activity of collecting data, data processing and explanation results (action and understanding are not separate in ARP and new theoretical structures can emerge at any moment, continuously censored by practice)
- an empirical approach *(Let The Problem Drive The Analysis!);*

- sharing opinions, ideas, results, especially with young researchers, thus helping them understand the knowledge generation process and the value of collaborative research.

The ultimate strategic objective of ARP is to solve a particular problem and to produce guidelines for best practice (Denscombe, 2010).

As mentioned above, the practical, tactical approach to ARP implementation involves a stepwise action and the essential steps are detailed in the subsequent paragraphs (Coughlan & Coghlan, 2002; Dick, 2009; Burns, 2014).

Involve stakeholders and young researchers from the very beginning of the study, in the planning phase as well as in the action. Instead of experts, professors, managers or authorities deciding the way to follow and the needs to do that, ARP reduces the gap between theoreticians and practitioners through participation; decision is the responsibility of everybody and the emerging commitment and more complete information are the driving forces for knowledge progress.

Flexibility and responsiveness.APR intrinsic flexibility comes from the permanent confrontation with the real world, due to its cyclic (or spiral) structure. As long as responsibility is everybody's, the delay between taking account of a new situation and the response shortens. It must be stressed that flexibility does not elude rigour. On the contrary, Action Research has all the features enabling the RD&I process to become more rigorous:

a. Action Research deliberately admits its early stage imperfections but ensures progress toward sound conclusions, thoroughly tested in practice – the most severe censor;

b. Participation enlarges the sources and possibilities of collecting information and data about a given situation.

c. Critical reflection that follows action is the tool that enables correction of previous errors or misjudgments.

d. All assumptions are reviewed and improved on a permanent basis and they are all tested in the next cycle of action.

ARP does not require a detailed planning and design in the starting phase. A general approach pattern should be adopted and this will be refined continuously during the process of Action Research, once more information about the processes studied becomes available. At every moment, the design and planning are tailored exactly to the process and they improve with every further step.

Action and critical reflection go hand in hand. Though human action is naturally followed by some reviewing activity of the results generated, APR makes this process of critical reflection compulsory, systematic and regular, leading the team to shared results in which everyone is more confident. Members of the team are called to critically examine the progress of the study, leaving less chance to

overlooking some essential facts. During the reflection, attention is particularly paid to those "non-linear" outcomes that do not fit in the expected pattern of knowledge and may be the source of new scientific evidence (What did and what did not work and why? Can we learn something? Should we replicate the action?)..

Research and action follow one another, in a spiral way. The critical reflection is followed by the planning of the next steps to be taken, guiding the team toward the new Action step (Fig.1).

In addition, the cycles or spiral steps of Action Research are not disjoint. There could be cycles imbricated in other cycles, spirals developing from the main spiral stem and coming back to that stem, etc. Action Research can therefore accommodate complexity and intricacy.

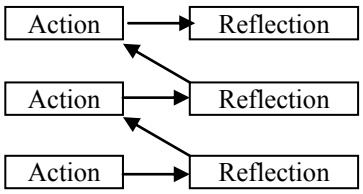

Figure 1. A simplified illustration of the spiral way of Action Research

A main feature of the Action Research, otherwise a fundamentally empirical approach is therefore that inquiry and testing are constant parts of the process.

Quantitative and qualitative data and information are of the same importance. Especially in the medical or educational but also in the environmental RD&I, the information is mainly qualitative. Neglecting it can gravely distort the results, so the team must find room for intangible aspects and qualitative facts in all their assessment. Qualitative and quantitative aspects will be present even in the beginning of the research process. There is no need to get detailed plan and to foresee all conceivable measures that should help carry out the job. The study can begin with more qualitative/imprecise/fuzzy rather than quantitative/exact appreciations and ideas. Further action and reflection will certainly improve the status of information and determine better future actions.

Change and understanding are simultaneous. Action Research is particularly suitable for studying dynamic systems, undergoing change and evolution. The spiral of understanding, action and reflection does not stop but continues as the systems evolves and adapts. This is the reason for what Action Research is implemented at so large a scale in social, medical, educational studies, as the characteristics of these systems are not immutable. Action Research detects changes and evolution as they take place and, by reflection, tries to adapt to the new system structure.

2. Industrial symbiosis and action research

The paragraphs details how the Industrial Symbiosis paradigm is currently implemented in the North-Eastern Development of Romania and how Action Research contributes to its success.

Industrial symbiosis is the sharing of services, utility, and by-product resources among industries in order to add value, reduce costs and improve the environment (Agarwal and Strachan, 2008). More than being a kind of brokerage activity for waste, Industrial Symbiosis projects try to identify all kind of resources, material waste, energy flows, production capacities, equipment, transportation devices, laboratory facilities, training capabilities, experts and trainers, etc., that are not fully used in a company and that the company is ready to share or give to any interesting partner. Industrial Symbiosis tries to mimic the ecosystems that do not produce waste but recycle and re-use everything.

Currently, the Industrial Symbiosis paradigm as a tool for improving environment state in EU and for generating innovative solutions in the field of environmental and technological RD&I is fully endorsed by the EU (EUR-ISA, 2014). In a flagship initiative (Roadmap, 2011), the European Commission highlighted the role industrial symbiosis schemes can play in achieving knowledge-based development and rethinking the resource management in EU. Other European organizations (EREP, 2014; GGGI, 2014) acknowledged the role of "facilitated industrial symbiosis" schemes in "diverting waste from landfill, contributing to the preservation of resources and moving waste up the value chain" and called for the wide-scale implementation of industrial symbiosis networks across Europe, expanding such success stories as the UK Symbiosis Programme (NISP, 2014). It also credited industrial symbiosis projects for accelerating innovation and creating green jobs.

Currently, EUR-ISA brings together organizations responsible for up to 10 established industrial symbiosis programs (collectively engaged with more than 20,000 companies across Europe) and provides the European Commission with a focal point to accelerate industrial symbiosis in Europe in order to generate substantial economic, environmental and social benefits.

A first Romanian attempt to implement Industrial Symbiosis was the ECOREG Project, limited to a single County (ECOREG, 2014). The driving force for the Project was the very poor performance of Romanian companies in recycling, re-using waste, exchanging resources and cooperating for a better environment (ANPM, 2014)

Currently, a new Industrial Symbiosis Project entitled *"Partnerships for Zero-Waste Industrial Activities"* (PAZEWAIA, 2014), financed by Innovation Norway is operational in a much larger area in the North Eastern part of Romania. The philosophy of the Project is to identify and reinsert in the economic and value chain

all kind of resources that are not currently used or are not used at full capacity, in the focal area of the Project.

The Project is carried out in the following manner:

a. Organizing a number of workshops gathering, each of them, 20-50 company managers, asked to complete special forms with their available resources that could be given or shared with symbiotic partners, as well as the resources they need and can be provided by other companies.

b. In the coming future, such events will be complemented by the intensive use of the INTERNET capabilities, this cutting costs and speeding up the circulation of information among interested companies.

c. Subsequently, the Project team identifies pairs of companies that could become partners in a symbiotic connection, by exchanging available resources. The most promising links are established by using an evaluation set of criteria and a multiple criteria decision making matrix. Criteria cover the triple bottom line of sustainable development (economic as well as the environmental and social aspects) of each potential symbiotic partnership.

d. Partnerships that seem most favourable from this triple bottom line are presented to managers and the PAZEWAIA Project team will support and offer advice for the materialization of the symbiotic partnerships.

e. Progress and actual results of implemented partnership are monitored in order to evaluate the amount of resources diverted from landfill and/or used to add more value throughout the value chain.

f. Best practices and expertize are shared via INTERNET.

A Project Advisory Board (PAB) was set up and includes local specialists, members form the local academic media, successful managers, representatives of local authorities, people enjoying the legitimacy and expertise that allow them to critically evaluate the Project. This is essential, as already shown, for the Action Research approach. As they came from local entities, PAB members are in the best position to know what are the priorities and capacities of local business community, what could be the sustainability of a specific issue.

Action Research is currently used, taking into account not only the specific of the focal zone but also the experience gathered during the previous ECOREG Project, in solving difficult problems connected to resource characterization, transfer, re-use and associated economical, technological, environmental and social impacts.

The contribution of Action Research can be summarized as follows:

a. Young graduates and future researchers, as members of the Project Team, are working together with Norwegian and Romanian experts, sharing scientific and management duties and responsibilities;

b. At the end of each PAZEWAIA Workshop, a thorough analysis of potential partnerships is carried out. In this reflection phase, experts and young team members exchange information about possibilities of reducing waste at their sources (a Cleaner Production module is included in the PAZEWAIA Project) adding value to waste by reusing it inside a company or by sending it to interested partners.

c. A special attention is given, using the expertize of the Norwegian partner, the background knowledge of local members of the academic media, etc. to resources that currently create technical, health, safety or environmental problems. E.g., broken bulbs from mercury-vapour lamps, organic waste coming from food processing plants, WEEE, etc. Brain storming session of the Project Team generates alternatives for re-use of these valuable resources. Such alternatives could be innovative or be new in the focal zone, encouraging managers to start new businesses.

d. Discussions with managers that could become partners and exchange resources in a future symbiotic connection usually generate new questions. Managers want practical information, best estimates of investment and operational costs, environmental impacts, etc. Implementing a symbiotic partnership becomes essentially a multi-disciplinary approach. Sound and up-to-date technological, scientific, economic, environmental information must be given to managers on the spot. Such a Project proves the limits of the educational system in Romania, since the university curricula do not include information from such diverse domains. The training advantage of an Industrial Symbiosis Project conducted according to Action Research coordinates becomes obvious;

e. Very modern techniques (e.g., Material and Energy Flow Cost Accounting, along the lines of ISO 14051) have been tested and implemented for the first time in Romania, in order to evaluate as exactly as possible the environmental costs of a technology and to convince managers of the favourable outcomes of a potential symbiotic partnership;

f. Both the ECOREG and the current PAZEWAIA Project pointed out to the very specific characteristics of each symbiotic partnership. Each company, each resource, each recycling alternative has its own profile. To this adds the character and openness of company managers to the new approach of Industrial Symbiosis. Apart of becoming aware of new technical or environmental aspect, Project team members, especially young ones, learned the difficulties and barriers of communications and personal relations.

Follow some examples of ideas of technical and environmental relevance, generated during the Action Research spiral, ideas that could lead, in the short term, to new businesses in the focal zone (adding the favourable impact of newly created jobs to the outcomes of the PAZEWAIA Project):

a. Use of food processing waste, especially animal bones, to extract collagen concentrates that, after thorough purification, could be used in medicine and cosmetics;

b. Extracting Nitrogen and Phosphorus compounds from hazardous waste (especially from medical waste). Such waste is currently destroyed by incineration at very high temperature, leading only to ash – a waste with no economic value. Yet such waste contains large amounts of nitrogen and phosphorus compounds. The cost of capturing, e.g., nitrogen in chemical compounds is very high (ammonia, as a first step, is synthesized at very high pressure and temperatures). Organic nitrogen and phosphorus existing in hazardous waste can be recovered by treating such waste with aggressive chemicals (e.g., sulphuric acid) that also guarantee the destruction of any micro-organism that gives the hazardous character of the waste.

c. The number of car and trucks in Romania has dramatically increased in the last years, generating huge amounts of waste. Instead of incinerating rubber tyres in cement kilns, rubber can undergo de-vulcanization and be re-used in manufacturing new tyres. Romanian patents in the field already exist and await investors to transpose them at an industrial scale;

d. Use of plastic waste in concrete recipes. A partnership with a large cement factory in the focal zone of PAZEWAIA is promising.

e. Smart use of fertilizers and compost, by local farms and communities in order to reduce costs and increase productivity. Local business companies could provide advice and expertize to farmers in choosing the best and least expensive way to improve land and crop quality;

f. A more aggressive public-private partnership in managing domestic waste. Results of s previous, Norwegian-financed Project (ESD, 2010) led to recycle rates of 32-34% in the focal zone of the Suceava County, while at the Romania level the recycle rate is about 5%. Experience will be expanded during the PAZEWAIA Project.

3. Action research and education

The benefits of Action Research in the education, training and specialization of young graduates and researchers have already become obvious from the previous paragraphs. Recommendations for including Action Research in academic curricula follow:

a. Dedicated courses and especially seminars dedicated to the Action Research approach should be inserted in the university curricula as soon as possible. Stress will be on seminars, as the features of Action Research cannot be taught *ex cathedra*.

b. Performing young students and graduates should become part or RD&I teams of their universities. They should be given tasks and responsibilities and a chance to work together with experts;

c. Enlarging the horizon of graduates by giving them the possibility to train in domains complementary to their specialization (e.g., engineers to be trained in ecology, economics, health&safety; economists to be trained in environmental science and accounting, cleaner production).

d. Small and Medium Size Enterprises (SMEs) should be encouraged to hire graduates and form them during the practice of their job (giving them responsibilities in improving the performance of the SME, rewarding them according to results);

e. Special incentives should be awarded by the state to SMEs to promote scientific and technological research. At EU level it is acknowledged that SMEs are the driver of innovative businesses, the laboratory for testing new industrial developments but financing such activities is still a desiderate.

Conclusions

The paper presented a way to address the important problem of the knowledge-based development by using Action Research in innovative industrial activities, in reducing the environmental footprint of companies.

As a valuable tool for generating knowledge and forming/training researchers and practitioners, Action Research is currently applied in a Norwegian-financed Project that aims to the implementation of Industrial Symbiosis in the North-Eastern part of Romania.

The main features of Action Research have been analysed and the importance of Industrial Symbiosis as a way to rethink the use of resource at EU level has been underlined. Also, the paper presented how Industrial Symbiosis and Action Research can go hand in hand and contribute, together, in a multi-disciplinary way, to the success of a Project aiming to sustainable development and use of resources in one of the less developed regions of Romania.

The Project comes also with an important contribution to the cooperation among Norwegian and Romanian experts and authorities.

References

Agarwal, A. and Strachan, P. (2008). *Is Industrial Symbiosis only a Concept for Developed Countries?*, The Journal for Waste & Resource Management Professionals, The Chartered Institution of Wastes Management; 42;

ANPM (2012), *Reports on the State of the ENVIRONMENT 2002 – 2013*, available at http://www.anpm.ro/Mediu/raport_privind_starea_mediului_in_romania-15 , accessed Oct 1, 2014.

ARNA (2014), *Action Research Network of Americas*, portal available at https://sites.google.com/site/arnaconnect/home , accessed October 1, 2014.

Bulsuk, K.G. (2009), *Taking-First-Step-With-PDCA*, http://www.bulsuk.com/2009/02/taking-first-step-with-pdca.html , retrieved Oct 2, 2014

Burns, D. (2014), *Systemic action research: Changing system dynamics to support sustainable change,* Action Research, 12(1), 3-18;

CCAR (2014), *Center for Collaborative Action Research*, Pepperdine University, a portal with various types of resources, available at http://cadres.pepperdine.edu/ccar/ accessed Sep 22, 2014.

Coughlan, P. and Coghlan, D. (2002), *Action Research for Operations Management*, International Journal of Operations and Production Management, 22(2), 220-240;

Denscombe M. (2010). *Good Research Guide : For small-scale social research projects* (4th Edition). Open University Press. Berkshire, UK, pag. 6.

Dick, B. (2009), *Action research literature 2006-2008: themes and trends*, Action Research 7(4), 423-441

ECOREG (2014), INTERNET Project Site, available at http://www.nisp-ecoreg.ro/default_en.aspx accessed October 2, 2014

EREP (2014), *The Portal of the European Resource Efficiency Platform*, available at http://ec.europa.eu/environment/resource_efficiency/re_platform/index_en.htm accessed Oct 1, 2014;

ESD (2010), *Environmental Solutions Development Project*. http://www.id-norway.com/country/romania/ accessed Oct 3, 2014;

EUR-ISA (2014), Portal of the European Industrial Symbiosis Associations, available at http://www.eur-isa.org/ , accessed Oct 1, 2014;

GGGI (2014), *The Global Green Growth Institute* Portal, Denmark, available at http://gggi.org/global-green-growth-forum/ , accessed Oct 4, 2014;

Kuhn, T.S. (2000), *The Road Since Structure*, Connat, J. (Ed), University of Chicago Press, USA;

Lewin, K. (1946), *Action Research and Minority Problems,* J.Soc., 2(4), pp.34-46.

NISP (2014), *The Portal of the National Industrial Symbiosis Programme, UK*, available at www.**nisp**network.com/ , accessed Oct 4, 2014;

PAZEWAIA (2014), News about the Project is available at http://www.id-norway.com/2014/09/successful-pazewaia-workshop-in-suceava-22-9-2014/ , accessed Oct 15, 2014

Roadmap (2011), *Roadmap toward a Resource Efficient Europe,* COM(2011) 571 final, European Commission, Brussels, Belgium;