

VIRTUAL ECO-INNOVATION HUB – A NEW TOOL FOR ENHANCING KNOWLEDGE TRANSFER AND INNOVATION IN THE FIELD OF WEEE RECYCLING

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ABSTRACT

The assumed global objective to fight against poverty through the development of green economy, adding the specific conditions of developing economies (Romania's case), requires the development of innovative tools to enhance the competitiveness of niche industry, generating a positive impact on social progress and economic growth, as well as on the environment.

This paper aims to analyze the contribution of virtual communities in fostering knowledge transfer and innovation. Acting as centers of knowledge integration and innovation creation, communities operate as a virtual innovation-hub, parallel to the traditional innovation labs. Despite its strategic role, relatively little is known about effectiveness of the hub in supporting knowledge transfer and innovation process. In order to gain insights to build a virtual eco-innovation hub, we study in-depth the case of WEEE (waste electric and electronic equipment, e-waste) recycling industry and define some propositions. The research contributes to fill the theoretical gap related to the organizational model of hub and to recognize the role of innovation-hub as an organization comprising multiple legally autonomous entities. Finally, it provides insights for WEEE recycling stakeholders to enhance eco-innovation, maximizing the value created by the innovation-hub.

KEYWORDS: *knowledge transfer, virtual eco-innovation hub, WEEE recycling*

JEL CLASSIFICATION: *O33, Q53*

1. INTRODUCTION

European Union's intention to develop a green economy is a great challenge for companies that must become eco-innovative. Eco-innovation is becoming gradually a priority in the EU, which deals with various aspects of all industries, both the traditional ones and eco-industries.

Under the Competitiveness and Innovation Program of the European Union (Decision 1639/2006/EC) the rationale to invest in eco-innovation is represented by the reduction of costs for materials and / or energy and thus, the increase of competitiveness and economic success. Europe is considered to be a strong player in the eco-innovation around the world. European countries hold approximately 30% of worldwide turnover in technologies and environmental services and EU countries account hold of 50% of the overall turnover of the recycling industry (in 2011). In this context, Romania is considered by the Eco-Innovation Observatory as a country with great potential for eco-innovation (due to the natural resources it owns, as well as to its renewable energy sources), but is still in the process of catching up with environmental performance compared to the EU27 average, one of the reasons being the lack of investment financing sources.

To face competition of companies from the European Union and from the rest of the world, Romanian companies should focus on openness to EU member states and the application of innovative technologies in order to increase competitiveness and efficiency. Business development in very narrow niches (such as in e-waste recycling), which the EU present market players do not

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cover, is a great opportunity for Romanian companies. To harness the business opportunities from the Community market, Romanian companies have a vital need for innovation and development of knowledge and technology transfer in economic sectors with potential.

Waste recycling is considered one of the eco-industries with great potential for innovation and growth in the EU. Worldwide the concerns regarding WEEE are growing. This fact is motivated by environmental impact and the perspectives of materials recovery. The differences between countries in terms of e-waste management in the European Union are notable. Romania is one of the countries that have made significant efforts to comply with EU regulations, but failed to reach the collecting target and has not made important progress on their efficient recycling.

Recycling companies and authorities are confronting with a large number of challenges related to e-waste recycling. These challenges aim at the disposal of hazardous components and recovery of a large quantity of recyclable materials, under security conditions for the people and the environment. Entrepreneurs (in particular SMEs) often face barriers to business development for e-waste recycling, especially in the implementation of eco-innovative technologies. To achieve this, the need for innovators should be visible and they must find support from the authorities and the business community. To overcome these barriers, entrepreneurs need access to:

- External knowledge for development and implementation of eco-innovative technologies for recycling.
- Management expertise to develop market penetration strategies, to minimize risks and to obtain finance.
- Support when entrepreneurs want to access new markets to find the best partners that understand the specific regulatory requirements.
- Support in analyzing the effectiveness of implementing innovative technologies for recycling e-waste and obtaining certification of their products.

In this context, this paper aims to identify the development stage of tools to stimulate innovation and knowledge transfer at global level. Based on the research results will be outlined key considerations which support the idea of designing a virtual hub of innovation in WEEE recycling field in Romania. The choice is justified by the importance given to this industry in recent years in the EU, but also by economic and environmental effects of WEEE recycling.

2. STATE OF RESEARCH REGARDING THE DEVELOPMENT OF TOOLS FOR ENHANCING INNOVATION AND KNOWLEDGE TRANSFER

As the world struggles to emerge from economic recession, at the national, regional and local level, new solutions are searched for stimulating economic growth and jobs creation. One of these is the development of collaborative systems and mechanisms that facilitate innovation and knowledge transfer. This category includes science parks, business incubators, the poles of competitiveness and economic clusters. These are geographic concentrations of interconnected companies, specialized suppliers, services providers, as well as firms from related industries and associated institutions that compete but also cooperate (Porter, 1998). Enterprises and research organizations or educational institutions, as the case may be, may be involved in the partnership. The purpose of these partnerships is the generation of synergies around innovative projects which are geared towards one or more markets.

Barsoumian, Severin and Spek (2011) perform an analysis on the relationship between clusters policy and eco-innovation in the EU27. The authors appreciate the role of clusters for establishing a set of formal and informal relationships between eco-innovators and the rest of the market players in the supply-production-sales chain, between eco-industries (as the case of recycling) and traditional industries, to promote access to highly qualified labor and environmental regulatory compliance for traditional industries. In particular, the authors highlight the role of clusters to stimulate knowledge transfer and cooperation between suppliers and customers. They establish a

close link between SMEs, large companies and research and development institutions and thus, may contribute to elimination of information asymmetry in the field of eco-innovation.

An advanced form of innovative cluster is considered to be the innovation hub. Innovation Hubs have the great advantage of being located in town centers, unlike the traditional concept of science and technology parks located in peripheral areas. INTELI (2007) identify 21 innovation hubs located in the center of the cities (areas with tens or hundreds of hectares) spread all over the world. A big part of the specialized literature does not distinguish between clusters and innovation hubs. At the policy level both terms are used in an arbitrary way. The most common concept used is the one of agglomeration, the clusters being considered agglomeration clusters with "proximity" as key variable. Henry and Pinch (2006) use agglomeration and cluster as synonyms to refer to the geographical groupings of companies (large and small, but mostly SMEs), which are part of the same sector, but which may extend beyond them to incorporate larger parts of the value chain. The concept of cluster accentuates the agglomeration and organization aspect, while the hub refers to knowledge sharing and the dissemination of them. Hubs can exist in the same locations as clusters or they can be embedded or independent of them.

Evers (2008) shows that a cluster of knowledge is a local innovation system organized around universities, research institutions and companies that intend to manage innovations and create new industries. In contrast, hubs are sites with architecture of knowledge and great capabilities of sharing knowledge, as well as internal and external relationships (Evers, 2008). The main problem facing the physical hubs is the placement and bottlenecks in communication between partners, and also between partners and other collaborators in the world.

Lange, Handler and Vila (2010), in a study conducted under the Cisco Internet Business Solutions Group, considers that with the appearance of new communication and collaboration services, the site does not have to be a major factor for success. Analyzing the factors that ensured the success of the world famous clusters (like Silicon Valley) the authors identify three pillars - network culture, international connections and sustainable innovation-which may be the basis for new forms of knowledge transfer regarding innovation.

By bringing together the stakeholders, there may be opportunities to create new worldwide partnerships to increase competitiveness of these groups by facilitating the transfer of ideas and knowledge. The flow of knowledge, ideas and data is in the center of research and innovation, and their transfer is performed more often in the virtual world than in the physical one. Partners are often remote from this point of view so that the "face to face" meetings are replaced with audio and video conferences. They work or study at any time of day or night, so that the e-mail, discussion forums, wikis, and similar instruments are used to enable communication between partners without all being in the same place (even virtually) at the same time. These tools also have the advantage that they can automatically register the evolution of ideas through group interaction.

Therefore, it is important to replace traditional mechanisms, i.e. clusters (usually a concentration in a closed space with a conventional working methodology) with *virtual innovation hubs*, which are open to worldwide opportunities, are not geographically restricted and are able to embrace the full potential of technology. This new paradigm requires three fundamental shifts (Lange, Handler and Vila, 2010):

- from similarly located communities to the digital communities that pursue the same interests;
- from locally made innovation to open, borderless innovation;
- from technology-based management to the use of technology for innovation and growth.

Virtual innovation hubs have globally appeared in recent years, in some areas of social and economic life (such as health: www.innovation.health.nz, urban architecture: <http://www.ecoinnovationlab.com/>, eco-trade) as a natural extension of the physical ones or independently from these. So far it has been reported that in Romania there are about 32 clusters and competitiveness poles in different areas (Coșniță and Banan, 2012), of which up to 5 are eco-innovative clusters (Barsoumian, Severin and Spek, 2011), but none of them is configured as a hub of eco-innovation.

The need to promote eco-innovation is fully justified given its importance in the EU2020 strategy, which aims to ensure smart, sustainable and inclusive growth. European Union Eco-innovation Action Plan (COM 2011) replaces and is based on the progress made in recent years by the action plan for environmental technologies. Thanks to this experience, the plan makes the interest in green technologies grow so that this interest finally leads to the creation of a larger concept, i.e. eco-innovation; the plan also identifies specific areas in which innovative technology can bring benefits. Eco-innovation issue has quite recently been set on the agenda of researchers and decision makers. One of the first appearances of the concept of eco-innovation in the specialized literature is found in the book of Fussler and James (1996). In an article published shortly after this book, James (1997) defines eco-innovation as new products and processes that create value to businesses and consumers and that significantly reduce the impact on the environment. Eco-innovation is often used as shorthand for environmental innovation (Rennings, 2000; Europe Innova). The most comprehensive approaches to eco-innovation include processes, equipments, products, new and modified management systems and techniques that eliminate or reduce environmental impact (Kemp & Arundel, 1998; Rennings, 2000).

EU Action Plan targets both supply and demand and uses six key factors to accelerate adoption of eco-innovation on market. They focus on the application of environmental policy and legislation, support for demonstration projects and partnerships, development of new standards, financial services and assistance for SMEs and international cooperation and support for training programs that contribute to acquiring new skills needed on the labor market (COM, 2011).

On the other hand, the Eurobarometer survey on European innovators' eco-attitudes, published in March 2011 (European Commission, 2011), underlined the access to business partners as a key factor for eco-innovation, with almost half of respondents believing that this factor is fundamental. At the same time, the limited access to external information and knowledge, and also insufficient access to grants and tax incentives were seen as major obstacles. In the opinion of Ockwell et al. (2010), one of the barriers that developing countries confront with in their attempt to develop eco-innovation is the lack of knowledge as regards the operation of eco-innovation, as well as its failure on the market. Besides the high costs and risks associated with eco-innovation, the incremental costs of eco-innovation are even higher as the market does not fully capture the benefits of eco-innovations. In case of collaborative mechanisms like clusters, for Romania an important barrier to innovation development is the fact that the 3 natural partners of the "Triple helix" model (such as companies, authorities, research organizations) do not cooperate and moreover, they do not know each other and do not get to talk to each other (Coșniță and Banan, 2012). There is a need to adapt the model and transform it into a "Four Clover" model, wherein the fourth actor is represented by the catalyst organizations – consulting firms specialized in technology transfer and innovation, transfer of technology centers. Such adaptation is performed by Cluster Association from Romania (www.clustero.eu).

This association is created through the Ministry of Economy, Trade and Business Environment (METBE), which since 2008 has developed a series of actions to identify the existing and emerging clusters in Romania. Of these actions one should mention the "Inov Cluster" project (2008-2010), pertaining to the Research and Development Sectorial Plan, which aimed to disseminate the concept of cluster innovation in Romania and international examples of good practice and to stimulate economic operators in order to create and develop innovative clusters by making specific tools (guide, portal, consulting services). In July 2012 the Association of Municipalities of Romania (AMR), whose premises are located in Deva, founded the Regional Platform for eco-innovation ECREIN+, which covers the development regions of North-West, West and South West.

Worldwide, but especially in the EU, the focus is on developing tools to stimulate eco-innovation in fields that have high potential to generate growth and have significant environmental impact.

Five years of implementing EU environmental technologies demonstrated the potential of eco-innovation to provide new business opportunities, growth and jobs in Europe. Eco-industries are already a representative economic sector with an annual turnover estimated at EURO 319 billion

(DGM, 2012). Eco-industries are superior to developing steel industry, as well as the pharmaceutical and automobile industries. Currently, the eco-industries register a growth of 8% per annum and this is noted especially in the sectors of waste and wastewater management, water supply and recycled materials (Bilsen, 2009).

3. CONSIDERATIONS FOR THE DEVELOPMENT OF A VIRTUAL ECO- INNOVATION HUB FOR WEEE RECYCLING IN ROMANIA

Waste recycling is one of the eco-industries with the highest growth potential, particularly WEEE. Worldwide, e-waste is the category with the highest growth rate of the quantity generated and one of the biggest challenges of the XXI century. Enhancing the rate of penetration of the market by EEE in developing countries, the development of "replacement market" in developed countries and the high rate of obsolescence determine WEEE to have one of the fastest growths in terms of quantity, and also in terms of material and component substances (more than 1,000 different substances). Thus, the amount of WEEE in the EU increased from 16 to 28% every 5 years (Huisman et al., 2008). While the amount of WEEE increases, the research in recycling field is still in its early days, especially in developing countries.

The presence of valuable recyclable components leads to the development of a disorganized and informal sector, which - through the risky and unsafe practices adopted - can generate strong risks for population and the environment. In Europe, although the concern for sector regulation has been manifested for 10 years (WEEE Directive 2002/96/EC amended by Directive 2012/19/EU), currently there is insufficient research on the impact of e-waste on the environment and recycling of WEEE is performed at an insufficient level compared to increased sales of electrical and electronic equipment.

In Europe, the most important project in the field of e-waste is conducted at the EMPA in Switzerland (the country with the most modern and completely WEEE management system in Europe): "Research partnerships with transition and developing countries in recycling e-waste field". The conceptual basis of the project follows the "double dividend" method, which is becoming increasingly popular in the field of researches. This is due to increased knowledge and an effective management, which may simultaneously enhance the economic and environmental performances. To this one can add a series of studies conducted under the auspices of UNEP for creating inventory models which are meant to measure quantity and categories of WEEE, to evaluate risks and recycle WEEE.

The concern for recycling e-waste and Romanian research in this area are still quite modest due to the multitude of stakeholders involved and the multiple aspects that the problem poses. The e-waste recycling includes (according Schluep et al., 2009): (i) collecting, (ii) sorting/dismantling and preprocessing (including sorting, dismantling and mechanical treatment) and (iii) final processing. According to UNEP, all three stages should operate and interact in a holistic manner to achieve the general objectives of recycling and innovation, and interaction should be facilitated by specific instruments. The main objectives of e-waste recycling and the basic considerations for innovation are (Schluep et al., 2009): treating dangerous fractions in an environmentally and friendly way, recovering materials with maximum value, creating eco-efficient and sustainable business, considering social impact and local context. In the study conducted under the auspices of UNEP, Schluep et al. (2009) show why – due to the lack of awareness as regards the complexity of e-waste recycling problem – centers of excellence or innovation hubs are not created in emerging economies, although recycler economic agents have the right potential to do this.

However, especially in developing countries, the barriers regarding innovative technologies and sustainable e-waste recycling can be difficult to overcome. These barriers are related to the possibility to participate in international knowledge transfer partnerships, clear regulations, a competitive environment with common norms that promote collaboration and development of innovative technologies.

In Romania, according to ANPM (2013) 774 companies are registered and authorized to collect WEEE, while 70 of them are authorized to treat WEEE. To these we should add six licensed operators that are authorized to assume responsibility for collecting WEEE. In terms of sector regulation, over 20 regulations – which are directly related to WEEE recycling – have been identified (Ciocoiu et al., 2013).

CCIB (2010) conducted an assessment of the eco-innovative companies in Romania – called EcoInvent – in order to make an inventory of them. Of the eco-innovative entities identified by the CCIB there are processing and waste treatment firms, and also GreenWEEE International, the largest factory of e-waste recycling in Romania.

All these elements justify the necessity to develop systems and mechanisms to facilitate the knowledge and eco-innovation transfer in order to increase competitiveness of WEEE recycling in Romania.

The issues that provide innovative features of a virtual eco-innovation hub are:

- **The novelty at national and international levels** of the virtual eco-innovation hub dedicated to WEEE recycling and the new tools available for eco-innovators, coupled with the support of potential users.

The virtual hub for eco-innovation is a novelty for Romania, representing an advanced form of economic clusters identified only in a few places in the world, but increasingly publicized. Unlike the portals or platforms of innovation which only make an interface between different entities / persons and provide information and tools to organize and develop themselves, the virtual eco-innovation hub will act as a network of excellence where the actors (authorities, companies, experts, trainers) learn, collaborate and share ideas and experiences. The hub role is to close the gap between marketing and research.

- **Usability**, in that it responds to the needs of business and research environments concerning the information, collaborative research, documentation and transfer of best practices. In Romania there isn't any platform for delivering all the services and information necessary for the various stakeholders implied in WEEE recycling.

- **Scalability, internationalization and openness to other projects and initiatives**

Although it is designed only for the WEEE recycling, the main facilities of the eco-innovation virtual hub could be replicated for other types of waste, and generally for other industries, ensuring scalability. An important element is the ability to continually increase the load on the hub with new functions and tools.

By offering to its members a wide range of online services highly responsive and customized the users loyalty will be improved. The list of such services is virtually endless, and ideas for hub extension will occur by observing users' needs for speed, concentration and greater socialization.

Internationalization has become increasingly important to the competitiveness of local industries. The access of investors from other countries is facilitated by the access to technical and scientific expertise provided by the eco innovation hub.

Some hub's activities involve interaction with stakeholders in the field of WEEE recycling. Interactions with other initiatives in the field of recycling or collaborative mechanisms for knowledge transfer and innovation will increase the chances of embedding a virtual innovation hub in other programs and the likelihood of successful transfer in the market.

- **Replicability and adaptability** – even if the tool are designed for the WEEE recycling, it must be easily adapted to other sectors such as renewable energy, sustainable technologies, etc. Exploring the possibilities of valorization of the hub will identify other opportunities to use the results in similar fields of activity.

Moreover, the eco innovation hub will prove its contribution by:

- *improved interaction between stakeholders* in the field of WEEE recycling, which will generate new ideas. These interactions may reveal areas of mutual interest, not previously identified,

resulting in innovative new partnerships to stimulate and accelerate economic growth and wealth creation beyond local, regional and international boundaries.

- *collaborating on a larger scale*, which will expand the number of potential collaborators and raise virtual bridges to connect partners from different geographic areas.
- "*coopetition*" (defined as cooperation in a context of competition), which will be exploited to its full potential, an alliance between the promoters of eco-innovation will have better visibility than a separate initiative.

A virtual eco-innovation hub has to be designed as a partner for promoting economic growth in the recycling industry and will enable the transfer of knowledge and technologies developed on the market. The connection between researchers and private partners through the hub will be done in two steps. Firstly, the social networking services will allow the contact. After making contact, the common tools and services offered will facilitate collaboration.

The virtual hub has no geographical boundaries, leveling the differences between local, regional, national communities and global levels. It supports entrepreneurship culture through a safe and secure virtual space where eco-innovators can meet, interact and work at any time and from anywhere in the world.

It will also provide educational and relationship opportunities for students and researchers to develop and be able to demonstrate the commercial value of their innovations, in the innovation lab. Researchers, educators and students could meet with private partners in the virtual training innovation center using the networking services, providing ample opportunities to develop and demonstrate the commercial value of their ideas.

Hubs are local systems of innovation, respectively nodes in production and exchange of knowledge networks. They can comply with three main functions: to generate knowledge, to transfer knowledge to the places where it is applied, and transmit knowledge to others through education and training.

A virtual innovation hub will include a public area and a private one (with access restricted to certain categories of users). The public area may contain an introductory section presenting the hub and the way was developed, a forum area (a video and audio conferencing infrastructure to enable virtual meetings), news, questions, contacts and the basic resources (the library of eco-innovation, training opportunities, and regulations). Restricted area may contain models and tools for companies and research environment, such as: recycling passports, cost-benefit analysis models, decision-making models, models for implementation of eco-innovative technologies, innovation and training labs.

Figure 1 shows schematically the actors which interacting on the innovation hub, the processes and the results of their interaction.

The implementation of such a tool assumes a comprehensive approach, distinguished mostly by the followings:

- the large volume of information which has to be collected and processed to find answers at the essentials questions which result from the analysis of the recycling market, the analysis of the functionalities of the other virtual hubs already implemented in the world and the analysis of users requirements;
- the research covers fields defined by correlations and multiple interferences. So, the analyses, measures and interpretations are very complex and they ask for special capacities of analysis and synthesis;
- taking in consideration the specifically aspects of these types of services: client oriented, the presence of a paperless environment, real time processing, the integration of front-office systems with back-office systems, the use of Internet, making decisions in an electronic environment, the automatization of the processes and dependence on information and communication technologies.
- the administration of broad categories of resources (material, financial, labor).

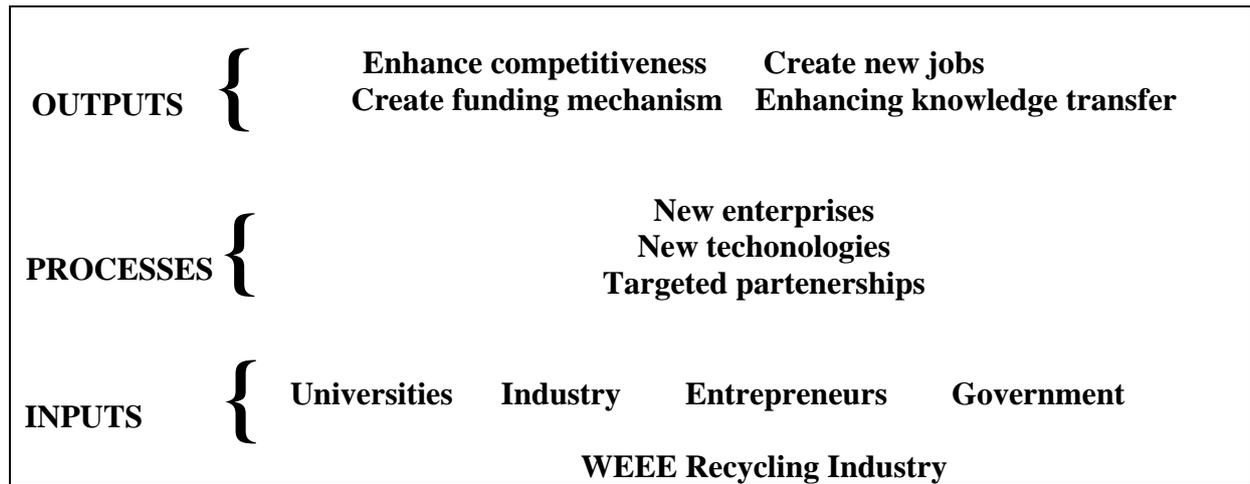


Figure 1. Inputs, processes and outputs of a virtual eco-innovation hub

It should be noted that there are barriers to the development of a virtual hub of eco-innovation. One of these is the very high cost of building and management, making the payback period to be long. Naturally such a hub must be designed so as to generate income for those who build it and take care of maintenance, considering a membership fee for users.

The development of a hub can be done through a consortium between multiple entities (universities, research institutes, public authorities with responsibilities in the field, companies), and funding can be achieved through programs of research, given the novelty of the tool.

4. CONCLUSIONS

A tool to promote eco-innovation and knowledge transfer in the field of waste electric and electronic equipment (WEEE, e-waste) recycling aims to face a challenge with profound economic, social and environmental implications, namely: increasing organizational competitiveness of firms that deal with e-waste recycling in Romania and enhancing involvement of the R&D public and private entities in promoting eco-innovation to develop the green economy

An eco-innovation hub will seek to identify and promote new technological, social and organizational innovations, which could be part of the future sustainable systems and will create conditions for: exploring, imagining, innovating, creating and testing ideas and concepts for sustainable and feasible technologies for recycling e-waste. The virtual hub of eco-innovation has to become a community of successful innovative companies in the field of e-waste recycling, whose primary purpose is to help to increase the quality of life by promoting a culture of innovation and competitiveness of enterprises and organizations based on associated knowledge.

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