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THE TRANSFER OF RFID TECHNOLOGY FOR STRENGTHENING COMPETITIVENESS OF THE COMPANIES OF AN INDUSTRIAL CLUSTER

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Abstract:
Contemporary environment of enterprises functioning in clusters is relentlessly changeable, even turbulent. The changes that occur in the market cause that even the entrepreneurs that cooperate within the scope of clusters are being forced to take decisions concerning continuous innovation implementation to maintain a proper level of competitiveness. However, the internal environment of industrial clusters and intra-organizational partnership based on mutual trust and commitment strengthen the interdependence of partners, increase the effectiveness of the common use of resources and are conducive to the transfer of technology and diffusion of innovations. The paper presents the innovative dimension of Radio Frequency Identification (RFID) technology and the possibility of its implementation in the companies of an industrial cluster, mainly within the scope of automatic data collection in IT systems. The main focus of the article is on the process of taking strategic decisions relating to the implementation of this technology in the context of the diffusion of innovations in industrial clusters. The author indicates that this process can be determined, *inter alia*, by the pressure of global comparativeness and operative effectiveness (the innovation of processes, the effectiveness of information circulation, the increase in data accuracy, the improvement of the quality of services, etc.). Moreover, it is emphasised that RFID technology, constituting an example of an eco-innovative solution, contributes to environmental protection and more efficient use of resources. It also generates a range of other advantages for its users, e.g., it contributes to more efficient management of the relationships with key stakeholders, the optimization of stock level, as well as supply processes, which, as a result, reduce the costs of running a business. The article aims to characterise the process of RFID technology transfer, as a potential element of intellectual capital of an industrial cluster, which is conducive to the strengthening of its competitiveness, including its members (mainly enterprises) which function in the conditions of knowledge-based economy. This work aims at the literature review of some aspects of the current developments in this field and the key conclusions, which will facilitate multidimensional characteristics of the problem and identify future direction of next research.

Keywords: cluster, management, decision, transfer, technology, innovation, competitiveness

1. INTRODUCTION

In the conditions of a turbulent environment, industrial clusters, being under high pressure for change, establish their prime goal to be permanent and intensive pursuit of the improvement of efficiency of activity, to ensure their further sustainable development on the market. Enterprises functioning in such clusters perceive the need, among others, for improving the management of supply chain, including quick and precise information storage concerning the number of stored materials and products, transported goods, provided services, etc. Additionally, increased competitiveness on national and global markets, fostering their development, e.g. as regards technical, product and organisational innovativeness, makes them identify newer and newer ways to improve the efficiency and optimise the use of resources. One of such ways is the transfer of RFID technology in various areas and scope.

RFID is a rapidly growing technology that has the potential to make great economic impacts on many industries (Bonde, Rane, 2014, p. 657). The technology as a one of most exciting technologies will open new doors to make organisations and companies more secure, reliable, and accurate (Ahsan, Shah et al., 2010, p. 6). Scientific research in this area has been growing at a rapid pace as is evidenced by the number of the articles and books published in the past 10 years.

The first part of this paper explains and describes the nature of an industrial cluster, the second part discusses strategic dimension of technology transfer and diffusion of innovations, and the third presents the main considerations of RFID technology in terms of its applications within a cluster. The author provides a nature of the RFID technology, its use in an industrial cluster, advantages, and barriers, implications and guidelines for RFID implementation on the basis of the published research work. This paper aims to identify the potential applications of RFID in cluster companies from multiple perspectives. Various aspects of RFID technology have been discussed in this paper, which clearly show the value of this remarkable technology. The author examined the potential benefits of RFID and identified the barriers to its acceptance in Polish industrial clusters as a member of a scientific team that will promote its adoption. He used a systematic method, which is divided into three phases: literature collection, categorization and analysis, to guide the literature review.

The paper presents the selected theoretical considerations within the subject. They constitute a fragment of the analysis of the conditions of companies' investment decision-making within the scope of the implementation of RFID technology that is presently conducted by the author. This paper was prepared within the scientific project: *"Synthesis of autonomous semi-passive transponder dedicated to operation in anticollision dynamic RFID systems"*.

2. INDUSTRIAL CLUSTERS AS A SPACE FOR THE DEVELOPMENT

For nearly 20 years now, almost in the entire world, clusters have been presented as a strategic factor of economic growth, including the one of knowledge-based economy. Ch. Ketels and M. Porter repeatedly emphasise that clusters are part of the economic reality, reflecting the balance of agglomeration and dispersion forces for specific economic activities because cluster strength is one of the important determinants of prosperity differences across geographies (Ketels, 2009, p. 8). According to M. Porter (2000, p. 25), the importance of clusters rises with the sophistication of competition and the concomitant rise in knowledge and innovation intensity, meaning that the incidence of clusters tends to increase with economic development.

Industrial cluster is often defined as a group of interconnected and spatially linked companies and associated institutions in a common or related industrial sector, characterised by commonalities and complementarities, enjoying positive location-specific externalities, faced with common opportunities and threats (Borghi, Del Bo et al, 2010, p. 1). The theoretical foundation of cluster concept is identified with (Porter, 2000, pp. 15-25; Rusu-Tanasa, 2014, p. 83; Fundeanu, Badele, 2014, p. 405; Szanyi, Csizmadia et al., 2010, p. 90, Morosini, 2004, p. 307):

- groups of numerous independent and complementary individual firms (start-ups, small, medium and large enterprises and research organisations) acting in a specific area, in order to stimulate innovative activity by promoting intensive interactions, the use of common resources, exchange of experience, good practices and by contributing to technology transfer, networking and information dissemination among the cluster's members, e.g. enterprises;
- collaborative groups of specialised firms operating in related branches of industry at the level of final products, raw materials, equipment, machinery and services, for instance, competitors,

users and producers of intermediary and final products, and producers of complementary goods and services;
- geographic concentrations of competitive industries that either have close buy-sell relationships, common technologies, or that share a labour pool that gives competitive advantage to businesses within a cluster;
- integrated group of firms, related economic stakeholders and institutions that are located close to each other and have reached a sufficient scale to develop expertise, services, resources, suppliers and specialised skills;
- flexible production platforms with some kind of activity specialisation;
- entrepreneurial ecosystem by which resources are valued and competences are shared, by which "young" companies benefit from a transfer of expertise through the participation in joint activities and common infrastructure (material and immaterial infrastructure);
- network-specific stable and intensive exchange relationships provide a precise knowledge of the strengths and weaknesses of potential stakeholders (e.g. clients or suppliers) which ultimately results in lower costs for search and negotiation;
- trust-building by cluster members measures result in the establishment of a clan-like inter-organisational culture in which opportunistic behaviour results in an imminent exclusion from the clan.

Taking into consideration the above cluster features, it is commonly accepted that clusters constitute an example of a contemporary form of organisation created by a group of entities from the sector of business and science, the representatives of non-governmental sector and local government, related by means of vernacular and horizontal dependencies, orientated towards development powered by the processes of organisational learning. High efficiency of this form of organisation manifests itself in spatial concentration of tangible and intangible resources, better performance of its entities, greater ability to generate and commercialise knowledge and innovation, effective encouragement to the creation of the concepts of new forms and signs of business. A cluster achieves synergy effect owing to formal and informal relations formed by the potential of cluster's intellectual and social capital, which not only describe the way in which this structure functions but are created and developed on the basis of common values, the realisation of common development strategy, including the exchange of knowledge and experience of cluster members. In the last years, many researchers have emphasised that the cluster "organisational structure" and entrepreneurial culture is characterised by the presence of systematic business and non-business relations among the local actors, sharing technical solutions for integrating the processes and technologies characterising the local production and a sort of "collective identity", based on common values, also with respect to the way in which businesses are carried out (Daddi, De Giacomo et al., 2012, p. 26).

3. TECHNOLOGY SPILLOVERS AND DIFFUSION OF INNOVATIONS WITHIN INDUSTRIAL CLUSTERS

Technology transfer and its role in the development of technological capabilities of industrial clusters were widely discussed over the last years. Industrial clusters need to compete in the fast-changing global industrial environment and to reach this; they have to survive for more than a few years. To survive longer and improve their competiveness, they need to acquire new technology and skills and they need efficient technology transfer.

The notion of technology transfer, which is commonly acknowledged to be a complex process, is interpreted in various ways, *inter alia*, as (Wahab, Rose et al., 2012, p. 63; Burhanuddin, Arif et al., 2009, p. 259):
- often a chaotic, disorderly process involving groups and individuals who may hold different views about the value and potential use of technology;
- a difficult process even when it occurs across different functions within a single product division of a single company;
- transmission of know-how (knowledge) which enables the recipient enterprise to manufacture a particular product or provide a specific service;
- a process that not only transfers the technical know-how (knowledge) required to produce the product to the recipient but also the capacity to master, develop and later autonomously produce the technology underlying the products;

- a process by which creative ideas and concepts are moved from the laboratory to marketplace;
- a process which involves an intentional, goal-oriented interaction between two or more social entities, during which the pool of technological knowledge remains stable or increases through the transfer of one or more components of technology;
- dissemination of information, matching technology with needs and creative adaptation of items for new uses;
- a process through which technology moves from outside sources to the organisation.

Many of the researchers do not draw a clear line between knowledge and technology transfer because most of the studies have regularly applied the term interchangeably in both technology transfer and knowledge transfer literatures; where the majority has treated knowledge transfer and technology transfer as having similar meaning (Wahab, Rose et al., 2012, p. 64).

Most frequently, technology transfer is associated with the flow of technically-technological knowledge in material as well as immaterial form between two parties of a transaction, i.e., a donor and a receiver. The donor of technology holds the copyright (a property) in a given technical solution and expresses the will to transfer their rights to a receiver under the previously negotiated terms. Whereas the receiver expects that the proper technology will be transferred to them, so that they can use it. Technology transfer understood in such way can be as simple as a shift of codified information from one company to another or it can be complex due to the varying capacity to understand or use information (Tihanyi, Roath, 2002, p. 190). It is commonly considered that the transfer is successful when the technology is brought into market (Burhanuddin, Arif et al., 2009, p. 259).

A skilful choice of external know-how sources, access to the channels of technology transfer, the evaluation of their usefulness and comparison of costs and benefits constitute for cluster members, mainly companies, the base for the formulation of development strategies, which are decisive for their success or failure. The rudimental methods of obtaining innovative technology within a cluster comprise: formal technology transfer (through formal contracts of purchasing licences, production lines, patents), informal technology transfer (by means of purchasing investment goods, components, technical consultations and techniques of copying foreign products) and the development of one's own R&D infrastructure.

The literature on new economic growth emphasises the importance of technological spillovers. Technology spillover effects are an inseparable element of an industrial cluster. Technology spillovers occur when a firm receives economic benefit from another firm's R&D activity without sharing any cost (Koo, 2005, p. 101). Spillover benefits include (Maine, Shapiro et al., 2010, p. 130) e.g.: knowledge spillovers from competing co-located firms; knowledge spillovers from public infrastructure, most notably from public research institutions; spillovers that emanate from suppliers and customers.

What is directly connected with a broadly interpreted process of technology transfer is diffusion of innovation theory, which is studied and applied in a vast array of academic disciplines. For instance, in scientific and popular science literature the terms "diffusion of innovations" and "spread of innovations" are used interchangeably and described as (Valente, 1996, p. 70; Murray, 2009, p. 110):

- the process by which a few members of a social system (e.g. clusters) initially adopt an innovation, then, over time more individuals adopt it, until all (or the majority) members adopt the new idea;
- the spread of abstract ideas and concepts, technical information, and actual practices within a social system, where the spread denotes a flow or a movement from a source to an adopter, typically via communication and influence;
- the process through which an innovation becomes diffused; it has universal applications to all fields that develop innovations.

The presented definitions of diffusion most frequently concern: the spread, dissemination and flow of information, ideas, knowledge, goods and services; physical diffusion or dissemination of certain objects, patterns; processes of production re-application of the same set of technical or scientific information. It is frequently indicated that the process of innovation dissemination (diffusion) is of temporal and spatial nature. The final results of diffusion are (Murray, 2009, p. 110): adoption (the decision to acquire the innovation), implementation (by putting innovation into practice and testing),

and institutionalization (by supporting innovation fully and incorporating it into typical practice routines). K. Karcz (2003, p. 59) indicates three dimensions of innovation diffusion, namely:

- the process of research, development and production, in which innovation is being properly processed until it can be materialised and commercialised;
- the transfer of innovation between enterprises within the scope of a determined economic arrangement and from one economic and social arrangement to another;
- the process of innovation diffusion within a social system, in which the decisions on innovation assimilation are taken by individual innovators.

In order to make the transfer of technology and innovation between participants, the associative structure requires the participation of the following categories of actors in a cluster designed according to the "Triple Helix" model (Fundeanu, Badele, 2014, p. 408):

- universities, research institutes, vocational training centres offering products, processes, innovative services, training;
- enterprises (including start-ups and spin-offs), which are meant to employ innovation and which should ideally lead and absorb the above - mentioned tender;
- central, regional or local powers for facilitating innovation processes.

The cluster environment creates stronger pressure to innovate a richer source of relevant ideas, and lower costs of turning ideas into new products and services (Ketels, 2009, p. 12). The economic subjects and research and development centres in a cluster can achieve higher level of innovativeness, as technology transfer and close members' interactions intensify the pressure for further innovations and, simultaneously, decrease the costs of the commercialisation of new ideas. A high density of contacts between the above mentioned internal cluster stakeholders at the level of a given region, on the basis of additional cultural and institutional closeness, particularly positively influence the flow of knowledge and technology transfer (Coccia, 2008, pp. 107-108). Taking into consideration the pro-innovative orientation of knowledge- and technology-based clusters, the following types of relations between the members of this organisation are distinguished in clustering theory and practice:

- cooperation of firms, also the competitors (coopetition) within the scope of a common research and development activity, which results in new concepts, technologies, products, services;
- cooperation of firms with the representatives of scientific and research sector and the institutions of business environment responsible for the support of the process of knowledge and technology transfer of formal and informal nature;
- formal knowledge transfer, innovation diffusion through the purchase of ready technologies in the form of appliances or licenses;
- transfer of implicit knowledge, which results from the mobility of employees between cluster members;
- cooperation of cluster members with key external stakeholders in an innovative process (a model of an open innovation).

Certainly, not every cluster generates spillover effects. This situation concerns only actively operating clusters, in which there occurs a wide range of formal and informal interactions between the members within the scope of the creation of value innovation. E. Maine, D. Shapiro and A. Vining (2010, p. 131) argue that location within a vibrant cluster, or proximity to such a cluster, enhances the performance of small, high-tech firms due to knowledge spillovers and proximate access to market-based benefits. The evolution of firms in a high-tech industry and in a high-tech cluster is mainly shaped by the underlying knowledge conditions, the so-called 'technological regime', which is a particular combination of appropriability (of the returns of innovation) conditions, technological opportunities (likelihood to innovate, given investments in research), degree of cumulativeness of technological knowledge (extent to which the amount of innovation produced in the past increases the probability of current innovation) and characteristics of the knowledge base (type of knowledge upon which firm's activities are based) (Iammarino, McCann, 2006, p. 1027). Owing to that, among others, small and medium firms functioning in clusters have access to new knowledge and can use the newest technologies without the necessity of costly investments, with the support of large companies with developed R&D facilities, as well as local and regional instruments of business environment, such as: centres for technology transfer, science and technology parks, and technological incubators. Whereas the thing that, for big companies, constitutes a value from this type of knowledge and technology transfer is acquiring new quality within the scope of cooperation with firms of SME sector, specialisation and standardisation of the realised processes.

4. RFID TECHNOLOGY FOR COMPETITIVENESS

The functioning in the conditions of a turbulent environment requires the entrepreneurs to seek newer and newer sources of competitive advantage. What plays a significant role in this process is the identification and creation of values on the basis of innovative RFID technology. In the contemporary business environment, apart from the new-age ICT like the Internet, e-commerce, bar-code systems and smart chips, RFID tool has given security solution and its application is helping enterprises and different business sectors (manufacturing, asset/product tracking, product handshaking, anti-counterfeiting, agriculture, safety and security, access control, condition monitoring, transactions, positioning/locating, market research, entertainment, e-commerce fulfilment, controlling grey markets, construction, industrial and warehousing, healthcare, airline industries, etc.) in various areas, including industrial clusters (Mamdapur, Rajgoli, 2011, p. 46). Industries use RFID for various applications such as analysing inventory information, personal/vehicle access control, departmental store security, equipment tracking, baggage, fast food establishments, logistics, etc. (Ahsan, Shah et al., 2010, p. 1). RFID technology and systems have become commonplace in access control and security applications, in industries requiring the tracking of products through the supply chain or manufacturing process, and in industries requiring the identification of products at the point of sale or point of service (Sarma, Weis et al., 2003, p. 454).

Scientific and popular science literature fail to provide an unambiguous definition of Radio Frequency Identification (RFID), as a result, this term is understood as:

- a prospective automatic identification method, being considered by many as one of the most pervasive computing technologies in history (Sun, 2012, p. 110);
- a generic term for technologies that use radio waves to automatically identify people or objects from a distance of several inches to hundreds of feet (Parkash, Kundu et al., 2012, p. 109);
- a generic term for technologies that use wireless communication between an object (also known as a tag) and an interrogating device (also known as a reader), for the purposes of automatically tracking and identifying of such objects (Iqbal, Singh, 2014, p. 2);
- new generation innovation for automatic data collection and asset tracking, fast developing technology that uses radio waves for data collection and transfer; it can capture data efficiently and automatically without human intervention (Yao, Chu et al., 2010, p. 128);
- a generic term that is used to describe a system that transmits the identity (in the form of a unique serial number) of an object or person wirelessly, using radio wave (Kaur, Sandhu et al., 2011, p. 151);
- new breed of Auto-ID technology that promises to deliver the next wave of productivity improvements to supply chain and other processes where tracking of products and assets or identification of people is required (Figarella, Kikirekov et al., 2006, p. 3);
- convenient and automatic instrument of identification and detection (Ajaegbu, Adesegun et al., 2014, p. 9);
- means of gathering data about a certain item without the need of touching or seeing the data carrier, through the use of inductive coupling or electromagnetic waves and a new way of controlling information and material flow, especially suitable for large production networks (Ilie-Zudor, Kemeny et al., 2006, p. 29);
- common standard for data storage and retrieval that could improve collaboration and data sharing between non-competing organizations (Shih, Chiu et al., 2008, p. 58).

The RFID technology itself can be used for a variety of applications, from contactless identification cards that can be scanned no farther than inches away from a reader, to highway systems utilizing “active” RFID tags that can initiate communication with a scanner 100 feet away (Majoras, Swindle et al., 2005, p. 3). International studies indicate that the RFID technology should not be seen as a substitute for other identification technology/systems like barcodes, because multifunctional capability of this kind of technology can provide additional features that allow its use for other applications that consequently add value (Wilding, Delgado, 2004, p. 32). Future RFID applications include, e.g.: smart products (clothing, appliances, CDs, etc. tagged for store returns), smart appliances (refrigerators that automatically create shopping lists, closets that tell you what clothes you have available, and search the Web for advice on current styles), smart services, recycling (Yadav et al., 2014, p. 863).

RFID plays an integral part in the technological revolution along with the Internet and mobile devices, which are connecting the world together. All RFID systems contain three main components: the RFID

tag, or transponder, which is located on the object to be identified and is the data carrier in the RFID system, the RFID reader, or transceiver, which may be able to both read data from and write data to a transponder, and the data processing subsystem which utilises the data obtained from the transceiver in some useful manner (Sarma, Weis et al., 2003, p. 456; Sun, 2012, p. 107). There exist many types of RFID, but at the highest level, we can divide RFID devices into three classes (Kaur, Sandhu et al., 2011, p. 151; Yao, Chu et al., 2010, p. 129; Ilie-Zudor, Kemeny et al., 2006, p. 30; Yadav et al., 2014, p. 861):

- active tags require a power source – they are either connected to a powered infrastructure or use energy stored in an integrated battery. In the latter case, a tag's lifetime is limited by the stored energy, balanced against the number of read operations the device must undergo;
- passive tags – in this case the tags do not require batteries or maintenance and have an indefinite operational life and are small enough to fit into a practical adhesive label (consists of three parts: an antenna, a semi- conductor chip attached to the antenna, and some form of encapsulation);
- semi-passive tags – use a battery to maintain memory in the tag or power the electronic parts that enable the tag to modulate the reflected signal – communicate in the same method as the other passive tags.

Passive tags achieved the greatest popularity with the clients, mainly, owing to small operating costs. However, this type of RFID activity still remains the technology which is not regulated by concrete international standards, in spite of the fact that a certain group of stakeholders (among others, scientists, trade association) attempt to create them. The standardisation will enable the choice of different suppliers of the devices and the cooperation of these devices in one installation.

As a result of the research, which brings new opportunities as well as challenges, RFID tags become cheaper and more powerful with improving technology and design experience (Parkash, Kundu et al., 2012, p. 118). According to K. Ahsan, H. Shah and P. Kingston (2010, p. 1), the enhancement in RFID technology has brought advantages that are related to resource optimisation, increased efficiency within business processes, and enhanced customer care, overall improvements in business operations. It should be emphasised that the following advantages suggest that RFID should be additionally applied for added value of identification (Ilie-Zudor, Kemeny et al., 2006, p. 31):

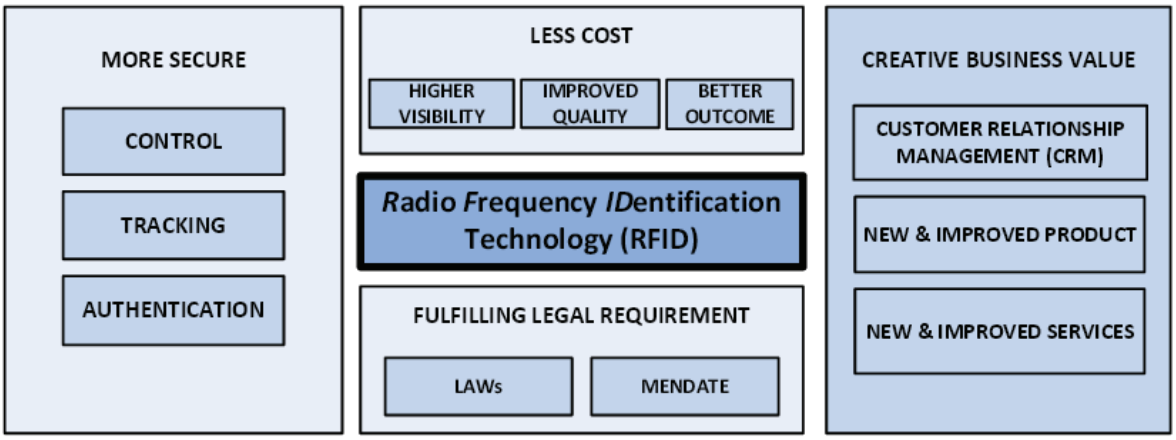
- tag detection not requiring human intervention reduces employment costs and eliminates human errors from data collection,
- tags have a longer read range than, e. g., barcodes,
- tags can have read/write memory capability, while barcodes cannot,
- tags can store large amounts of data additionally to a unique identifier,
- unique item identification is easier to implement with RFID than with barcodes,
- tags are less sensitive to adverse conditions (dust, chemicals, physical damage etc.),
- many tags can be read simultaneously,
- tags can be combined with sensors,
- automatic reading at several places reduces time lags and inaccuracies in an inventory,
- tags can locally store additional information; such distributed data storage may increase fault tolerance of the entire system,
- they reduce inventory control, provisioning costs and warranty claim processing costs.

RFID is a stable technology which carries proved business benefits (Fig. 1). Thus, this technology grows in popularity and the number of people who are interested in its implementation is constantly increasing. Many researchers stress, that RFID is an emerging and innovative technology that can enable business process redesign in order to optimise operational efficiency and productivity (Mishra et al., 2010, p. 367). Until today, remarkable potential has been achieved using RFID technology not only for making business well-disciplined, but also for improving personal life standard (Saleem, Khan et al., 2012, p. 5). The results of the study confirm that RFID technology is seen valuable because of its ability to collect data in real-time. Moreover, this kind technology may have a valence toward surveillance, such that the location of individuals is tracked and analysed under the rubric of management paradigms like "workflow management" (Kaur et al., 2012, 1375).

The systems that use this kind of technology are treated as a link between the production environment and business systems. For example, in IT systems RFID helps to improve automatic product or semi-finished product identification during the process of their manufacturing and further on. Also in the textile industry, it is very useful in tracking textile products at every stage of their existence (Barburski,

Czekalski et al., 2008, p. 95). RFID technology is currently used in the pharmaceutical industry to combat drug counterfeiting (Crooker, Baldwin et al., 2009, p. 162).

Figure 1: Some visible features of RFID technology



Source: Saleem, Khan, Afzal, 2012, p. 1.

The implementation of RFID technology requires a system-wide reorganization and significant infrastructural and organisational changes (Nambiar, 2009, p. 1253). A general classification suggests three cost categories (Baysan, Ustundag, 2013, p. 14):

- hardware cost – covers the costs of tangible elements of RFID system, such as tags and readers;
- middleware cost – is the cost of software and infrastructure that supports and simplifies RFID-related operations;
- service cost – such business processes redesign cost and configuration cost; requires an elaborate study on the firm and supply chain specific requirements.

Contemporary experience of the implementation of this technology indicates that the payback period depends on the volume of a project. Quick payback in RFID in large companies is possible owing to the fact that in industrial installations there are applied available and trusted technical solutions. The foremost requirement for the implementation of RFID technology within cluster is the presence of wireless infrastructure (Kaur et al., 2012, p. 1374). The system of wireless data collection is a part of RFID system, which enables quick and faultless information gathering and, basing on this information, building databases which rationalise the work of a given enterprise. RFID technology has already been applied effectively, it has certain organisational and technical barriers (e.g. high investment, lack of security and privacy, lack of expertise, resistance to change, lack of top management support and lack of system integration) that still need to be overcome to optimise its application (Dahariya, Naik et al., 2014, p. 32). It is believed that when the RFID technology matures even more, and the competition increases in the industry, better tags and equipment will become more economical. It may only be a matter of time before RFID technology will create new emerging markets, completely replace barcode systems and become the standard for every organisation in developed and developing countries (Mamdapur, Rajgoli, 2011, p. 56).

RFID market is the most dynamically developing sector of radio communication industry, including mobile phones. This technology develops concurrently with the growth in the expectations of the receivers, which encourages to its newer and newer applications. The global industry for RFID technology has been growing steadily since past few years and is expected to grow rapidly before stabilising and settling on a steady growth path (Wen, Zailani et al., 2009, p. 25). Strategic decisions within the scope of the implementation and maintenance of new solutions in the area of RFID technology in the enterprises of an industrial cluster are most frequently taken under pressure of the competition in national and international dimension as well as operative effectiveness (e.g., process innovation, improvement of the visibility of circulation of information, increase in data accuracy, the quality of services, labelling and tracking of goods, ensuring supply security). Frequently, it is large companies with foreign capital, functioning in an industrial cluster and perceiving the merits of this technology, and which in a natural way force its implementation in other, cooperating with them companies. P. Schmitt, F. Thiesse and E. Fleisch (2007, p. 12) indicate that the most significant factors of RFID technology diffusion in the automotive industry are the following:

- compatibility (e.g. technological, hardware, software and data standards),
- costs (e.g. hardware components, system integration and customisation),
- complexity of the technology and its implementation (e.g. because of process change, lack of plug & play components, non-trivial data processing, etc.),
- performance (e.g. technological capability and environmental influences on systems),
- top management support (e.g. perception of RFID as a strategic technology).

The scope of the transfer of this technology in a given industrial cluster can be determined by such factors as: the present needs concerning RFID, the quality of cluster management, type of a cluster (e.g., high-tech, low-tech), nature of the sector in which the majority of cluster members function, the life-stage of a cluster, the life-stage of the transferred technology, the ability of cluster members to adapt innovations, the level of social capital, including the level of trust in relations between cluster members.

Presently, the major challenge for cluster companies is the choice of the supplier that ensures not only a flawlessly operating RFID system adjusted to the characteristics of the production process and the supply chain but also professional technical support. What is crucial in the case of RFID solutions is a proper pre-implementation analysis, including the ability to choose appropriate models of readers, tags and other accessories. In this instance, it transpires that knowledge and technology transfer within a cluster can be more beneficial than undertaking such activity outside a cluster structure. Basing on the knowledge and experience of the partners and also good and bad practices as regards the implementation of this technology, every person subsequently interested in this technology will be able to implement it in more efficient way, than it has been done previously.

What is significant for building competitive advantage of the companies of an industrial cluster based on innovative technologies is an autonomic semi-passive identificator, intended for work in multi-tag, dynamic RFID systems. Although, research and development work within this scope are still in progress, e.g., in Rzeszow University of Technology, it is already known that this innovative technology will be more economical and effective in comparison to the so-far applied RFID systems (obtaining energy from the environment for autonomic work of an identificator, detailed information on the object and its environment). The progress particularly regards the decrease in the cost of the implementation of such systems based on RFID technology, the increase in the speed of transmission and tag storage capacity. The ideas of the application of radio technique emerge concurrently with the development of the technology itself. It is assumed that, over the course of time, mass application of this technology at relatively low implementation costs will cause a high level of satisfaction of its users (Jankowska-Mihulowicz et al., 2014, pp. 13-17). The work being realised by “RFID team” at Rzeszow University of Technology, is consistent with the global research, which aims to increase the possibilities of the application of Radio Frequency Identification Systems.

5. CONCLUSION

Industrial clusters, as an example of a partner network, which is conducive to technology transfer, comprise enterprises and other stakeholders (e.g., R&D units, institutions of business environment), concentrated on common goals and values. P. Morosini (2004, p. 307) argues that within an industrial cluster, a significant part of both the social community and the economic agents work together in economically linked activities, sharing and nurturing a common stock of product, technology and organisational knowledge in order to generate superior products and services in the market place. The heterogeneous firms within a cluster can often more rapidly source the new components, services, machinery, and other elements needed to implement innovations, whether in the form of a new product line, a new process, or a new logistical model (Porter, 2000, p. 24). The transfer of resources between cluster partners is of repetitive, not temporary nature; reciprocal expectations of the partners comprise longer time frame, the information available to the partners is far broader than in the case of market coordination, and negotiation and agreement are the form of the coordination of activities between the partners. Clusters basing on mutual trust and involvement strengthen the inter-dependency of the partners, improve the quality of the common use of resources and facilitate efficient technology transfer, contributing to successful diffusion of innovation. It should be emphasised that technology transfer and diffusion of innovation takes on even greater importance for productivity growth in developing industrial clusters.

In contemporary socio-economic conditions, the competitiveness of clusters, including enterprises, is not limited to the national scene but, due to the dynamic globalisation processes, it has to be transferred to international arena. More and more frequently, it is emphasised that globalisation, facilitating the entrance of the companies with greatest global potential into local markets, makes the other actors undertake actions orientated to continual increase in their level of competitiveness.

In view of the increasing competitiveness, the ability of quick adaptation of innovations becomes for cluster members particularly significant. It ensues mainly from a number of benefits, which can be derived by the partners who decide on this undertaking. For instance, joint ventures of the partners within the scope of RFID technology transfer can contribute to the reduction in the costs associated with running business activity (e.g., the costs of storage, stocktaking, transport of materials and products), owing to, e.g., automatic management of tangible assets, automatic production management, data protection, improvement of the process of managing an integrated supply chain. Whereas, common knowledge resources concerning, for instance, new technologies can encourage the partners to actively overcome the threats that occur in the environment, including the existing and the potential barriers to the implementation of RFID technology.

The transfer of RFID technology within a cluster can transpire very beneficial for a number of the participants of this network, even due to the possibility of common development of their strategic potential, which is conducive to effective adaptation of this technology. It is not insignificant to jointly overcome the financial barriers to efficiently obtain new technologies, or technological distance as compared to the competitors, which is particularly important for small and medium firms. Thus, cooperation within a cluster can result in a continual development of the competitiveness of a cluster and its members, including the development of innovative potential.

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