EFFECT OF USING KNOWLEDGE SOURCES ON PRODUCT AND PROCESS INNOVATION IN THE CHEMISTRY INDUSTRY

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Abstract: Innovation plays a key role in building competitiveness and sustaining economic growth.The reason of this increased competition has forced companies to develop new products and explore new markets in order to meet the needs and wants of consumers competitively. Knowledge sources play a crucial role to understand consumer needs and wants. This paper aims to explain effects of using knowledge sources on product and process innovation. Knowledge sources are specified as market sources (suppliers, customers, competitors, and consultants), institutional sources (universities, public research institutes) and other sources. Necessary data is gained by CIS–4 (Community Innovation Survey) which was based on the OECD's Oslo Manual. This survey is implemented in the chemistry industry. In the part of the methodology correlation analysis is applied between knowledge sources and product innovation; knowledge sources and process innovation. Differences of using knowledge sources for product innovation and process innovation are explored. It is expected to find effect of knowledge sources to increase product or process innovation of firms.

1. INTRODUCTION

Increased competition has pushed companies to become more efficient in processing, to reorganise management, develop new products and explore new markets in order to meet the needs and wants of consumers competitively (Avermaete et al., 2003). The market opportunities of firms and the development opportunities of regions depend increasingly on their capacity to contuniously generate innovative products and processes. Innovation, therefore, plays a key role in building competitiveness and sustaining economic growth (Sternberg, Arndt, 2001). Many firms seek new ways of conducting their business through some kind of innovation to make a profit and stay ahead of the competition (Laforet, 2008).

Innovation is by definition, novelty. It is the creation of something qualitatively new, via processes of learning and knowledge building. It involves changing competences and capabilities and producing qualitatively new performance outcomes (Fagerberg et al., 2005). According to Peter Drucker "Innovation is the effort to create purposeful focused change in an enterprise's economic and social potential" (Davila et al., 2006).

If we want the innovation process to be a manageable source of sustainable competitive advantage, understanding under what conditions innovation activities may in fact be complementary is more important than determining what activities are complementary (Cassiman, Veugelers, 2006). Knowledge plays a more and more crucial role in fostering innovation. The growing importance of knowledge as a production factor and as a determinant of innovation can be explained by the continuous expansion of the amount of technical knowledge accumulating over time, and by the use of communication technologies that makes the knowledge available very rapidly on a worldwide scale (Cowan et al., 2000).

Firms tend to complement their in-house capacity for creation of knowledge through acquisition of knowledge from external sources, that is through another mechanism: the network. The network theories of innovation have evolved progressively from networks with clients, suppliers, research partners, and more recently, to a much larger set of institutional

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and social actors. Networks would contribute to enhance the firm's ability to identify and develop innovation opportunities that could not be identified and developed otherwise (Amara, Landry,2005:245).

External knowledge flows constitute a prototypical example of external knowledge sources that a firm can potentially exploit to enhance innovation performance (Escribano et al., 2009:97). In order to valorise external resources, two factors are required. Firstly, the company must have the appropriate tools and capacity to communicate and to stock the external knowledge according to its needs. Secondly, it must have put in place appropriate processes to assure an optimum diffusion of this knowledge among its staff in order to exploit the knowledge and generate added value (Lengrand, Chatrie,1999).

Some researches predict that the more sustained and intense the interactions between firms and external sources of technical information, the more likely the technical information will be used to develop innovations that are world first introductions on the market, rather than innovations that are first introductions at the national level or for the firms (Amara, Landry,2005:248–249).

Innovation is influenced by many actors and sources of knowledge both inside and outside the firm. It is constituted by using knowledge sources. This paper examines to explain effects of using knowledge sources on product and process innovation. Firstly importance of knowledge sources and innovation is explored. Secondly in the literature review studies which had been interested in knowledge sources and their effects on innovation process are handled. Research methodology of this paper includes correlation analysis between knowledge sources (enterprise, suppliers, customers, competitors, consultants, universities, public research institutions, conferences, fair, exhibitions, scientific journals, commercial publications, profession and industry foundations) with product innovation and process innovation seperately. And differences of using knowledge sources for product innovation and process innovation is explored. Necessary data is gained by CIS–4 (Community Innovation Survey) which was based on the OECD's Oslo Manual. This survey is implemented to 52 firms in the chemistry industry.

2. LITERATURE REVIEW

Innovation can be understood as a process of learning and knowledge creation through which new problems are defined and new knowledge is developed to solve them (Fagerberg et. al., 2005: 124).Today, firms can not rely on solely on internal knowledge sources to make successful innovation. Firms should give necessary importance to knowledge sources.

The benefits of using knowledge sources can be listed (Caloghirou et al.,2003,p.88);

i. R&D cost sharing
ii. Risk sharing reducing uncertainty;
iii. Accessing (external) complementary resources and skills;
iv. Exploiting research synergies;
v. Facilitating technological learning;
vi. Keeping up with major technological developments;
vii. Improving speed to markets;
viii. Achieving critical mass in R&D;
ix. Creating and promoting technical standards;
x. Promoting user/producer interactions;

xi. Controlling future market developments;
xii. Creating new investment options
xiii.Obtaining public funding; and
xiv.Establishing new relationships.

Firms do not have internally all of the necessary resources (including knowledge) and/or because they wish to reduce the risks associated with innovation (Tether, 2002:950-951). Some partner types are essential to innovation projects (so that difficulties in managing them indeed result in failed innovation projects) as well as more delicate to collaborate with (so that some kind of difficulties do sometimes arise and put the innovation project at risk). Generally speaking, the degree of market rivalry between partners, the complementarity of their skills and the cultural distance between them are usually emphasized as determinants for cooperation stability (Park and Ungson, 2001). External resources by cooperating with other organizations provides economies of scale and scope and obtain synergy effects. They can also reduce the risk of innovation by sharing costs among the members and mitigating uncertainty through the acquisition of better information (Okamuro, 2007).

Cohen and Levinthal (1989) argue that the desire to assimilate external knowledge creates a positive incentive to invest in R&D. They find indirect evidence of the relationship between innovation performance and absorptive capacity by showing that external knowledge flows encourage investment in R&D. Focusing on collaborative linkages in the biotechnology industry, Cockburn and Henderson (1998) show that the ability to maintain close ties with the scientific community is a key factor in driving a firm's ability to recognize and use upstream research and findings. Moreover, connectedness is significantly correlated with performance, in drug discovery.

Kaufmann and Tödtling (2001) have found that only three types of innovation partners had a significant positive effect on the introduction of products ''new to the market''suppliers, consultants, and universities. Universities stimulated or enabled firms to introduce more advanced innovations, whereas contract research organizations had no positive effects in this respect. ''Pure'' science, consequently, seemed to be more effective in stimulating advanced innovations than applied research focusing on commercialization. Fritsch and Lukas (2001) found a little more than 60% of the enterprises in their sample maintained cooperative relationships with their customers, nearly 49% had cooperative relationships with their manufacturing suppliers, 85% with business oriented service firms, 33% with public research institutions and about 31% with "other" enterprises.

More recently, Cassiman and Veugelers (2006) show that the reliance on more basic R&D, which might proxy a firm's absorptive capacity, is a contextual variable positively affecting the complementarity between internal and external innovation activities. Nieto, Santamaria, (2007) indicates that **c**ollaboration with suppliers, clients and research organizations in this order have a positive impact on the novelty of innovation, while collaboration with competitors has a negative impact. The greatest positive impact on the degree of innovation novelty comes from collaborative networks comprising different types of partners.

The generally most frequent innovation partners—the customers—had neither a positive nor significant influence on the introduction of advanced innovations. However, other partners from the business system, suppliers and consultants did have such a positive influence. They seemed to transfer important technology and know-how to innovating firms, enabling them to introduce more advanced innovations (Tödtling et al., 2009:63). Firms that collaborate for

innovation with their customers are, concomitantly, reducing their ignorance of customer needs, increasing users' confidence in their offerings and, thereby, reducing the risk associated with bringing an innovation to market (Tether, 2002:950–951).

Füller and Matzler (2007) demonstrate how customers can be virtually integrated into a company's innovation process. Access to information creates a chance to develop customer centred, really new products. Franke, Schreier (2002) added need-related information is very expensive to acquire and complex to transfer, customers might have problems giving the manufacturer a clear and complete picture of what they want and it is very difficult to translate need-related information into solution-related information.

Co-operative relations with suppliers share many of the features of relations with customers. Suppliers are sources of information sharing many of the advantages generated by the customers and suppliers as sources of information used to develop or improve products or processes. Amara and Landry (2005) and Nieto and Santamaria (2007) emphasize the role of key suppliers for bringing forward product innovations.

Competitors can greatly enhance the knowledge base of a firm because competitors usually have similar needs in terms of product or process development so that the knowledge base developed by a firm may be particularly relevant for its competitors.

It is not certain that competitors will be systematically very cooperative in sharing their knowledge, however. Theoretical results as well as empirical evidence show that firms will rather try to capture some of their partner's knowledge while simultaneously limiting knowledge leakages towards him, which could endanger the viability or the success of the partnership (Lhuillery, Pfister, 2009:47). According to the some authors, the monitoring of competitors seems to be a more relevant mechanism for knowledge transfer and innovation than input–output links or cooperation (Tödtling et al., 2009:62).

Miotti, Sachwald (2003) explains competitors are complementary R&D resources. They may be attractive partners to team up with in order to reduce costs and risks for large projects. Caloghirou et al. (2003) do not find a significant impact of competitors on the overall success of R&D partnerships either. Running regressions over a sample of Swedish firms, Janz et al. (2003) even find that R&D co-operation with competitors has a negative effect on innovative sales.

Co-operating with consultants can provide a variety of inputs to the innovation process, in roles that go beyond the traditional provision of expertise. These include: experience sharing, playing a diagnostic role in helping firms to articulate and define their particular needs for innovation and pairing companies with needs and solutions (Tether, 2002:953).

Researchers in public laboratories pay more attention to scientific value and have less regard to market value (Dasgupta, David, 1994). The management of intellectual property rights is also often reported as problematic (Hall et al., 2000): companies would often prefer to keep their research results secret until they have been patented while public researchers have a scientific and economic incentive to publish as soon as possible. Caloghirou et al. (2003) do not find that collaborating with a public research organizations (PRO) has any impact on the overall success of R&D partnership. Fritsch, Schwirten (1999) suggest that the research institutions are a key player in regional innovation systems. On the one hand, several recent empirical results indicate that such partnerships have a significant impact on the firm

performance (Lhuillery, Pfister, 2009:47). Co-operation with public partners does not involve commercial risk. Public research institutions do not seek commercial applications and tend to focus on the most generic or basic end of the R&D complex (Miotti, Sachwald 2003).

Universities are seen as especially useful for basic and long-term strategic research, particularly in pre competitive technologies; the sorts of research that many firms regard as excessively expensive to undertake alone, using only their own resources. When coupled with the available funding opportunities, including those from the European Commission, co-operation arrangements with academia are increasingly seen as an inexpensive and low risk source of specialist knowledge (Tether, 2002:953).

Universities operate on extended time lines and have little regard to the urgent deadline of business. Second, an efficient knowledge sharing process implies that the scientific or technological distance between partners is not too large (Lhuillery, Pfister, 2009:47).

Lööf and Broström (2008) find evidence that university collaboration positively influences innovative performance of large Swedish manufacturing firms, in terms of sales of new products per employee. Hence, Medda et al.,(2006) find that Italian firms earn positive returns from collaborative research with other companies, but not from collaborative research with universities. Miotti and Sachwald (2003) similarly find that the share of innovative products in turnover is only increased by vertical co-operation but not with universities. Janz et al. (2003) find no significant impact of R&D co-operation of Swedish firms with universities or research institutes on innovation performance in the same period. On a small set of Japanese SMEs, Okamuro (2007) even find that R&D cooperation with university are negatively related to commercial success.

3. RESEARCH METHODOLOGY

Our aim is to indicate effect of knowledge sources on product and process innovation. Firstly we inspect relationship between knowledge sources and innovation. Correlation analysis is implemented. Then we evaluate survey results to create an idea about importance level of knowledge sources according to firms. In our research, firms are asked whether they introduced new or significantly improved products and processes. And these firms mark importance level of each knowledge source as high, medium or low. Survey based approach is implemented to evaluate innovation performance of firms. This survey is implemented to 52 chemistry firms.

The results of our correlation analysis are reported in Table 1 and Table 2. The fact that there is positive relationship between product innovation and knowledges sources. And interval of correlation coefficient (r) for product innovation is 0,541 and 0,681. This positive relationship is indicated also for process innovation in Table 2. Correlation coefficient (r) for process innovation changes between 0,783 and 0,916. It shows that knowledge sources more effective on process innovation than product innovation.

Table 1. Correlation Matrix For Product Innovation

Correlation	Product innovation	Enterprise	Suppliers	Customers	Competitors	Consultants	Universities	Public research institutions	Conference,fair, exhibitions	Scientific journal, commrcial publications	Profession and industry foundations
Product innovation	1,00	,638**	,664**	,541**	,583**	,528**	,594**	,569**	,681**	,576**	,631**
Enterprise	,638**	1,00	-,878**	-,824**	-,755**	-,759**	-,794**	-,721**	-,755**	-,807**	-,756**
Suppliers	,664**	-,878**	1,00	-,897**	-,823**	-,806**	-,829**	-,777**	-,829**	-,832**	-,851**
Customers	,541**	-,824**	-,897**	1,00	-,847**	-,830**	-,752**	-,756**	-,807**	-,846**	-,839**
Competitors	,583**	-,755**	-,823**	-,847**	1,00	-,726**	-,683**	-,728**	-,802**	-,766**	-,770**
Consultants	,528**	-,759**	-,806**	-,830**	-,726**	1,00	-,903**	-,915**	-,818**	-,825**	-,855**
Universities	,594**	-,794**	-,829**	-,752**	-,683**	-,903**	1,00	-,913**	-,806**	-,818**	-,837**
Public research institutions	,569**	-,721**	-,777**	-,756**	-,728**	-,915**	-,913**	1,00	-,787**	-,812**	-,878**
Conference, fair, exhibitions	,681**	-,755**	-,829**	-,807**	-,802**	-,818**	-,806**	-,787**	1,00	-,906**	-,914**
Scientific journal, Commercial publications	,576**	-,807**	-,832**	-,846**	-,766**	-,825**	-,818**	-,812**	-,906**	1,00	-,908**
Profession and industry foundations	,631**	-,756**	-,851**	-,839**	-,770**	-,855**	-,837**	-,878**	-,914**	-,908**	1,00

Table 2. Correlation Matrix For Process Innovation

Correlation	Process innovation	Enterprise	Suppliers	Customers	Competitors	Consultants	Universities	Public research institutions	Conference,fair, exhibitions	Scientific journal, commrcial	Profession and industry foundations
Process innovation	1,00	,916**	,898**	,896**	,830**	,831**	,804**	,783**	,881**	,903**	,851**
Enterprise	,916**	1,00	-,878**	-,824**	-,755**	-,759**	-,794**	-,721**	-,755**	-,807**	-,756**
Suppliers	,898**	-,878**	1,00	-,897**	-,823**	-,806**	-,829**	-,777**	-,829**	-,832**	-,851**
Customers	,896**	-,824**	-,897**	1,00	-,847**	-,830**	-,752**	-,756**	-,807**	-,846**	-,839**
Competitors	,830**	-,755**	-,823**	-,847**	1,00	-,726**	-,683**	-,728**	-,802**	-,766**	-,770**
Consultants	,831**	-,759**	-,806**	-,830**	-,726**	1,00	-,903**	-,915**	-,818**	-,825**	-,855**
Universities	,804**	-,794**	-,829**	-,752**	-,683**	-,903**	1,00	-,913**	-,806**	-,818**	-,837**
Public research institutions	,783**	-,721**	-,777**	-,756**	-,728**	-,915**	-,913**	1,00	-,787**	-,812**	-,878**
Conference, fair, exhibitions	,881**	-,755**	-,829**	-,807**	-,802**	-,818**	-,806**	-,787**	1,00	-,906**	-,914**
Scientific journal, Commercial publications	,903**	-,807**	-,832**	-,846**	-,766**	-,825**	-,818**	-,812**	-,906**	1,00	-,908**
Profession and industry foundations	,851**	-,756**	-,851**	-,839**	-,770**	-,855**	-,837**	-,878**	-,914**	-,908**	1,00

Figure 1 shows firms evaluations which of them introduced new or significantly improved products. They mark high level importance sequencely suppliers (62,1%) first, their enterprise or enterprise group and customers (48,3%) second, conferences,fair,exhibitions (44,8%) third. The least important knowledge sources for product innovation are universities(10,3%), consultants (17,2%) and public research organizations(20,7%).

Figure 1. Product innovation and importance level of knowledge sources

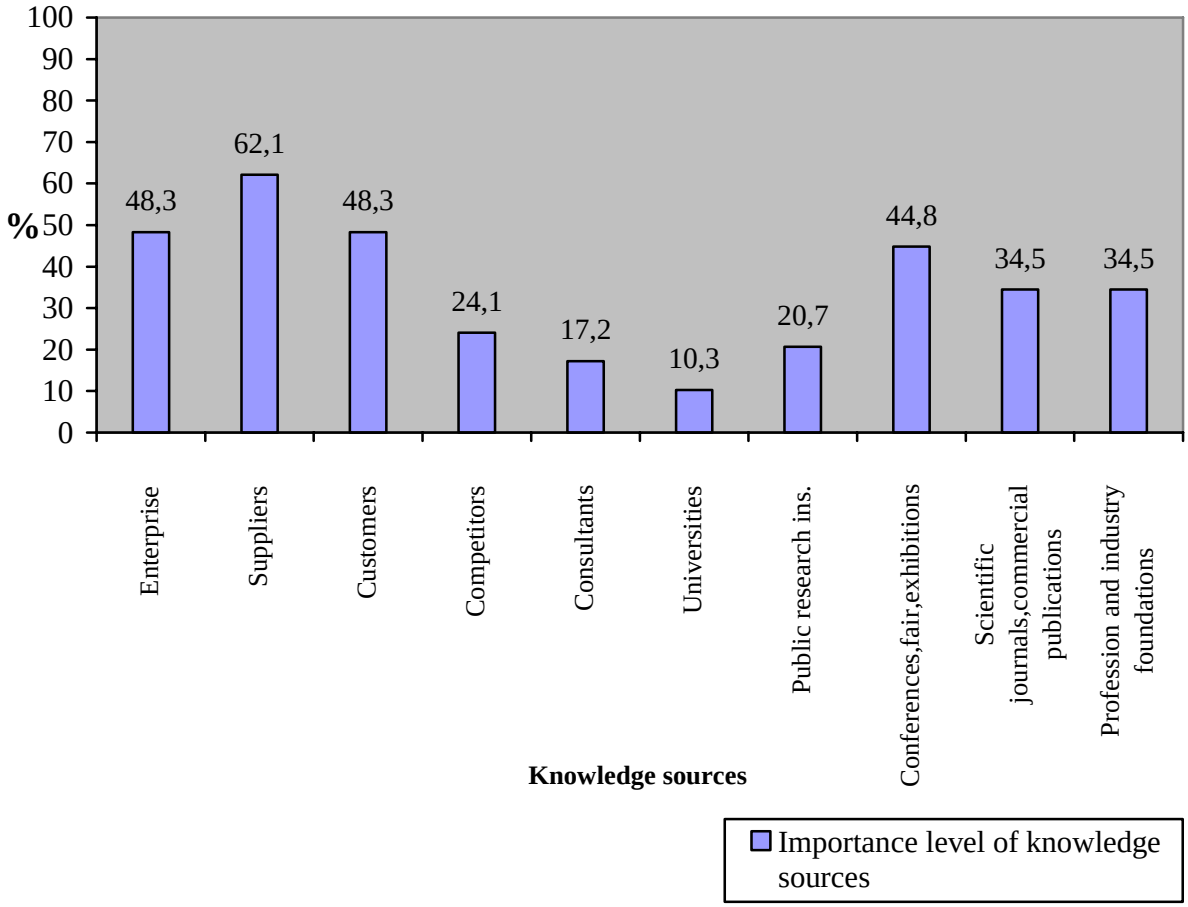
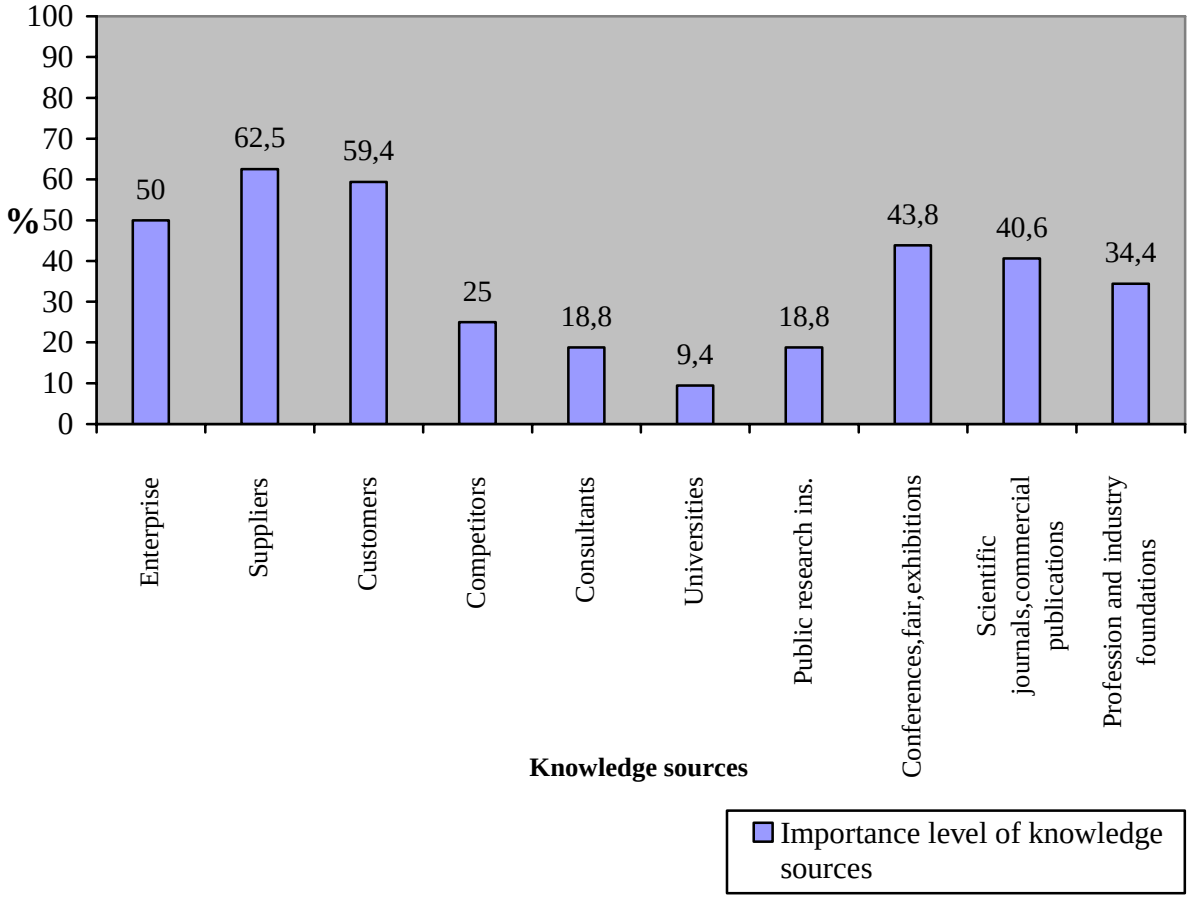


Figure 2 shows firms evaluations which of them introduced new or significantly improved processes. They line up first three as suppliers (62,5%), customers (59,4%), their enterprise or enterprise group (50%) for process innovation. Conferences, fair, exhibitions for process innovation isn't found as important as product innovation. And the least important knowledge sources of process innovation are the same with product innovation.

Figure 2. Process innovation and importance level of knowledge sources



If we look at the reason under this result, the most important knowledge sources are from the business sector. Suppliers are working with not only one enterprise but also many enterprises. So they have more opportunity to follow new trends and new market demands and establish new relationships which provides keeping up with technological developments. They are an important link in the firm's overall customer value delivery system. Through the innovation process cooperation with suppliers improve speed to markets.

Customers are also highly important as a knowledge source to control future market developments. Knowledge diffusion is very fast in the world so customers wants and needs always change. Cooperation with customers reduces uncertainty and ignorance of customer needs. To provide customer satisfaction, customers' feedback should reflect to innovation process.

Enterprises can create innovation activities with stimulating projects. They tend to take account of market demand, profit maximization and competition while creating projects. Internal capabilities, power relations of enterprises contributes to commercialization of knowledge.

4. CONCLUSIONS

Adaptation to rapidly changing markets and gaining competitive advantage requires to be innovative and have knowledge about related developments. Knowledge sources generate positive contributions, they raises possibility of becoming aware of market or technical

developments with related industries. In our research inspects effects of these knowledge sources on product and process innovation.

Our results point that business sector is evaluated more important for knowledge sources of innovation process. Firms tend to trust to suppliers, customers and their own enterprises. On the other hand, universities, consultants and public research organizations have low importance according to firms. Firms think that they extend the boundary of knowledge but competition, market demand and profit maximization are subsidiary important for them.

Whereas being included of universities to the innovation process creates powerful mechanism to spread of academical knowledge into industrial and other occupations. Universities should be more entrepreneurial to generate closer links with industry. And firms can keep up with new developments which are created by universities and they can get support through their needs on new or improved product and process. Conferences, fair, exhibitions, scientific journals, commercial publications are potential sources to share knowledge and follow new developments. Profession and industry foundations provides to assembling of related foundations, sharing knowledge, supporting innovation activities.

Economic risk, high costs, unavailability of finance, market dominated by established enterprises, uncertain demand for innovative goods or services and any other factors can constraint innovation activities. But today unavailability of knowledge shouldn't be seen restrictive factor. Firms should benefit from potential of knowledge sources while decide to innovate. Not only internal and market sources but also institutional sources, conferences, fairs,exhibitions, scientific journals, commercial publications, profession and industry foundations should be evaluated as knowledge sources

The limitation of this research is that it includes chemistry industry only. In this sense there is a possibility of changing of results for different industries

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