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New product development in a low-tech knowledge-intensive framework: insights from GSF, a University-industry collaborative project

Karagouni G.*[1], Papadopoulos I.[1], Trigkas M.[2]

[1]Technological Educational Institute of Thessaly, Department of Wood & Furniture Design and Technology, V. Griva 11, Karditsa. Greece, 43100

papad@teilar.grkaragg@teilar.gr

[2]Aristotle University of Thessaloniki – Department of Forestry & Natural Environment, Lab. of Forest Economics, Finikas Thessaloniki, building B, 55134 mtrigkas@for.auth.

*Corresponding author: E-mail:karagg@teilar.gr

Abstract

The paper sheds some light on an important but rather under-explored topic: the collaboration between low-tech, firms and universities. Whereas the motives, obstacles and impacts of university-industry collaborations are rather well empirically documented, the process of collaboration still remains poorly analyzed, there is scarce evidence considering low-tech industries and hardly any concerning the university perspective. The single case study method is used based on a New Product Development research project, the Green and Smart Furniture project, co-developed by a Technological Institute in Greece and a furniture firm. It actually focuses on the NPD and the capabilities of the research team to run the collaborative project successfully. Results indicate certain differences from the usual perceptions of R&D collaborations commonly studied within high-tech sectors. They further confirm the fact that low-tech innovation is based on various knowledge sources from different disciplines. Research teams have to establish trust and familiarity with low-tech firms, exercise strong managerial and technical capabilities as well as the ability to reach and creatively combine knowledge. NPD is dynami requiring different degrees of commitment of the stakeholders. However, changes in culture of both sides seem to be imperative in order to promote fruitful knowledge-intensive collaborations within the low-tech framework.

Keywords: New product development, furniture industry, low-tech industry, University- industry collaboration, knowledge-intensive

1. INTRODUCTION

In the last few years a rich literature is emerging enhancing the role that traditional sectors play in modern economies and directing importance of innovation and technological change outside R&D-intensive fields (Hirsch-Kreinsen and Schwinge, 2011; Robertson et al. 2009). There is now a growing awareness that low-technology industries, which still make up a considerable share of production and employment in developed and developing economies, can be knowledge-intensive, develop knowledge-based innovation and invest in trans-sectoral knowledge seeking and learning (Hirsch-Kreinsen and Schwinge, 2011; Caloghirou et al., 2014).

Low-tech industries engage mainly in new product development and frequent changes of process technologies (Hirsch-Kreinsen, 2008, Robertson and Smith, 2008, Robertson et al. 2009). While a very small percentage of individual low-tech firms engage in R&D activities, the majority appear to apply mainly open innovation based on demand and absorption of acquired or created knowledge. Especially when referring to knowledge-intensive innovation, a common issue for low-tech is that processes translate knowledge to innovation; i.e. in-house knowledge is developed by including new knowledge and technologies that stand out from the resources of the existing sectoral system (Robertson and Smith 2008; Hirsch-Kreinsen and Schwinge, 2011). This can be scientifically-generated knowledge as well as new combinations of technical and practical knowledge which create innovation.

In general, low-tech firms are quite reluctant to co-operation with universities and public research organizations (e.g. Seggara-Blasco, 2010). However, low-tech firms of an innovative culture seem to be more willing tojoin common innovative efforts with scientific organizations, technology liaison offices, political institutions, associations, chambers of commerce and industry or also regionally focused support programmes.

Existing research on university-industry collaborations has mainly focused on high-technology issues regarding mainly firms of this category. Besides the arising interest in low-tech innovativeness, theoretically driven and empirically-based research exploring factors, processes, mechanisms, constraints or factors affecting university-low tech industry innovation projects remains relatively scarce.

2. LITERATURE REVIEW

Low-tech knowledge-intensive (LT-KI) firms tend to rely on complex knowledge bases (Hirsch-Kreinsen and Schwinge, 2011) instead of just embodied and codified knowledge (Robertson and Smith, 2008 for low-tech industries) in order to innovate. A significant feature of low-tech innovation is the engagement of many stakeholders all along the value chain in open innovation; knowledge often stems from various sources permeating through sectoral boundaries (Hirsch-Kreinsen and Schwinge, 2011; Robertson and Smith, 2008).

In many cases LT-KI firms do not just adjust or adapt to existing technology paradigms already developed in the more high-technology industries. They are also key users of high-tech ideas (Santamaria et al., 2009), and can contribute significantly to the development of technologies and knowledge diversification directed to new technological fields (Mendonca, 2009). These firms by being ‘lead users’ place special demands on new technologies and call for novel performance attributes that exceed the normal requirements of the average user.

Consequently, low-tech industries are often far more intensive as creators and users of knowledge than usually acknowledged, with cognitively deep and complex knowledge bases. Therefore, external knowledge sources such as machine manufacturers and suppliers, other firms, organizations and other actors play a decisive role in the innovation strategies of LMT firms (Heidenreich, 2009; Hirsch-Kreinsen, 2008; Grimpe and Sofka, 2009; Santamaria et al., 2009). Furthermore, empirical literature confirms the complementarity with high-tech industries, as initially pointed by Heidenreich (2009); KI-LT firms open new market opportunities for high-tech industries.

New product developmentconstitutes the main activity of a firm to offer novel products,adapt products to the specific needs of different customers and market niches, and to actively promote and market the developed products/services. It can be R&D-driven or market driven or even a combination of the two in order to enter new market segments and stimulate

customer demand (von Tunzelmann and Acha, 2005). It has been called a key source of sustainable competitive advantage (Teece, 2007) for all industries and a core dimension of innovativeness (Laestadius, et al., 2005).

Danneels (2002) exploring product innovation considered NPD related to technical, customer, and managerial capabilities; a) technical capability enables the physical development of new products by understanding product technologies, evaluating the feasibility of product designs, testing prototypes, and assessing technical specifications; b) customer capability regards the marketing and commercialization of the new products; c) managerial capability is the ability to manage the NPD process.

All three capabilities appear to be more intense in cases of NPD collaborations and open innovation. In such cases, networking enables the formation of mutually beneficial business relationships (Protogerou Caloghirou and Karagouni, 2014). However, while networks with suppliers and machine manufacturers are quite usual in low-tech firms, co-operation with universities and public research organizations (e.g. Seggara-Blasco, 2010) is scarce and has been observed in cases of LT-KIE (e.g. Karagouni et al., 2012). University-industry collaborations have been studied from different perspectives(e.g Perkmann and Walsh, 2007; Agrawal, 2001); authors have focused on firm characteristics such as absorptive capacity (Cohen and Levinthal, 1990), describe the collaboration process (Perkmann and Walsh, 2007) orsignificant factors such as trust and familiarity (Sherwood and Covin, 2008), and explore types and determinants of knowledge interactions (Schartinger et al., 2002) or examine the typologies of collaborative projects between SMEs and universities (Santoro and Chakrabarti, 2002).

However, it appears that "there is less effort by the Academia exploring university–industry collaboration in less tech intensive sectors" (Hervas-Oliver et al, 2012). Furthermore, research efforts that approach the issue either compare high to low- tech categories (e.g. Arundel and Geuna, 2004; Freitas et al., 2013) or include low-tech in other examined groups such as SMEs (Buganza et al., 2014) or the industrial dynamics of regions and countries (e.g Schartinger et al., 2002). In general, researchers conclude that firms in mature industries collaborate with universities mainly to enlarge their general knowledge base by blending new and old technologies and facilitate higher levels of technology integration with embodied knowledge (Robertson and Smith, 2008; von Tunzelmann and Acha, 2005).

In sum, it appears that besides the increasing interest on the issue, there is no empirical research on how low-techuniversity–industry collaborative projects devoted to developing new products, are actually managed. Up to date, such collaborations appear to be rather self-evident. Our claim is that such collaborations are not static: they actually bare certain peculiarities regarding the process and the specific capabilities needed by the academic teams in order to end up with successful low-tech but knowledge-intensive innovation.

3. RESEARCH FRAMEWORK AND METHOD

The core of the research project under the name "GSF - Green and Smart Furniture"was the co-development of intelligent and purely ecological furniture that would provide a better experience of house life without overloading the users with technology. The project was developed by the*Department of Wood & Furniture Design and Technology in Thessaly (Greece) and addressed mainly the furniture industry*. Furniture industry is mature, highly fragmented and labour-intensive with many firms operating in a 'craft' production mode. Most firms cannot be considered as innovative even with the Schumpeterian concept of innovation (Karagouni et al., 2012). The sector plays still a significant role in the European

economy. The last decade it faces growing competition from low-cost, emerging economies and a growing number of technical trade barriers. Furthermore, it faces difficulties in accessing wood as a raw material and a dramatic rise in the price of materials such as leather, plastics natural fibres and petroleum derivatives (Tringkas et al., 2012). The general financial and economic crisis has had a major impact on the entire sector in Greece with production losses to approach the 80%. Within this framework, the GSF proposal was rated with a high degree by the Research Funding Program: ARCHIMEDES III and started in 2011. The project is still running.

The GSF case is a suitable context to provide insights into how NPD collaboration between a university department and a firm of a mature industry is deployed, especially from the academic side. Case study research is a useful method for research works that aim to produce a first-hand understanding while a single case study can provide more details and depth (Yin, 2013). The present work focuses on a three-phase process including the three capabilities as described by Daneels (2002) and developed in Buganza et al (2014) and Xiao et al. (2014):(1) Applied research i.e.the set of activities associated with seeking, using and developing new knowledge, methods and/ or techniques for the GSF object; (2) Development i.e. the actual design and development of the product, resulting in the final design and prototype; and (3) Testing which regards the set of activities devoted to testing product performance, set production and fine-tuning products before the market launch.

In all steps managerial and technical capabilities (Daneels, 2002) are examined, excluding consumer capability.

4. RESULTS AND DISCUSSION

The GSF project offered rich insights considering the exploration of such university-industry collaborations, allowing for comparisons with the usual R&D collaborations which dominate in the relevant literature. *Collaboration was proposed by the university side*: the research team selected the company for a number of reasons and namely, due to: a) former collaboration mainly on testing and student training, b) the positive, innovative culture of the company and c) the relevance and flexibility of its production. This is in line with relevant literature;contrasting high tech R&D collaborations, low-tech firms seem rather reluctant to establish such partnerships (e.g. Hirsch-Kreinsen, 2008), and usuallyuniversities are out of reach of them. Furthermore, testing has been also denoted as the first step of collaborations, extending to more complex forms after trust has been established (Buganza et al., 2014)

There was a clear difference among initial aims and targets. Actually, the individual aims from the University side were

a) The creation of new knowledge and broadening of interdisciplinary research expressed by patents, research papers and announcements as well as new educational material
b) The establishment of networking mechanisms with the furniture industry at least at regional level.

The individual aims of the corresponding company were

a) The development of new competitive advantage based on the innovative product and the increase of its market share
b) The commercialization of the innovation

Different targets and time lags among academic research and industrial interest have been often reported and discussed in literature (e.g. Bruneel et al., 2010). However, this has not been mentioned as a problem in scientific research collaboration of high tech industries. On the other hand, it appears a major obstacle in low-tech cases. More specifically, within the GSF project, the company was called to work on new technologies although it was not clear whether it could commercialize the novel product or take advantage of the new knowledge. In cases of mature industries it is very difficult to overcome prejudices, define markets and requirements. On the other hand, academic research deals mainly with the unknown while

profits are not measured in revenues. According to Buganza et al. (2014) CEOs complain that even if they find the suitable professor, sometimes they have to work hard on directing efforts towards their wishes. This conflict becomes even more intense in cases that projects start by academics.Experience, familiarity and established trust played a significant role in the convergence of the individual expectations of the different parts.

A consequence of the different perception of time and scope is also the issue of management. Since the research team was the coordinator, members should also manage the complex collaboration. However, time devoted has a different meaning for an industry. Active involvement required a high degree of technical and managerial capability of the two parts. The research team appeared to own the technical capability i.e. the ability to select, combine and create knowledge, apply it on the creation of the novel green and smart furniture and develop the prototype. However, the team's managerial capability seemed to suffer in the phases of the prototype development and the setup of the pilot production: problems were mainly traced in the assessment of technical specifications, the co-operation of the individual teams in incorporating the new electronic parts or the commitment to purely "green" materials. This indicated a problematic distance between theory and practice which constitutes the most usual drawback assigned to academic research. The fact indicated the firm's weaknesses in the technical capability and the research team's weakness in managing the implementation of research to the physical product.

*The inclusion of a wide variety of different knowledge bases*comprised a challenge for the two parts and constitutes a major difference with the respective high-tech research projects. In order to accomplish the targets of the GSF project, the research team had to seek knowledge bases inside and outside the Department's boundaries. In fact, besides the Marketing and Management Department that was the project's coordinator, most of the Department's laboratories offered knowledge on: novel material reflecting the totally ecological nature of the product, green production technologies, changes needed to be incorporated in production due to the specificities of the product,norms for the respective quality control and of course design as the means of integration among inventions, aesthetics, markets and production processes.

Knowledge sought outside the boundaries of the Department regarding electronics combined to green technology and their incorporation in production. This research activity was carried out quite successfully, with a fruitful exchange of know-how among participants and the creation of incorporated technology, codified and tacit knowledge. Yet, it regarded rather an internal activity mostly within the barriers of the department. It should be mentioned that there was some indifference by the firm-side to become more involved observed, as well as a reluctance of the research team to motivate the firm to do so. This confirms further the established opinion of the separate roles of the two parts (industry – university) besides the intentions of the coordinator to bridge this gap. However, the investment in knowledge was quite fruitful and led to radical innovation. On the other hand, the firm offered valuable practical knowledge at the stage of pilot production. Thus, the successful and within schedule selection, elaboration, creative combination and creation of new knowledge indicated a significant level of both managerial and technical capabilities of the research team which seem to apply more when stakeholders belong to the same side, i.e. academia.

The mass production and the novel product's commercialization remain at this stage questionable.Besides the marketing plan and the feasibility study included in the deliverables of the GSF project, there are certain challenges regarding dimensions such as industrial standards, the collaborative firm's potential and capacity and even its commitment to the proposed product. This can be considered a significant drawback of university-directed research in low-tech sectors contrasting again the high-tech counterpart; even firms of a more open culture to challenges remain rather skeptical in adopting radical innovation as their core strategy.

5. CONCLUSIONS

The present work was based on the GSF research project while its results shed some light on an important but rather under-explored topic: the collaboration between low-tech firms and universities. Whereas the motives, obstacles and impacts of university-industry collaborations are rather well documented through a growing number of empirical analyses, the process of collaboration still remains poorly analyzed and there is scarce evidence considering low-tech industries. Furthermore, literature considers the efficiency of the university side rather self-evident; so, there is hardly any answer to the research question: How do *universities* cooperate with companies?

The study clearly indicates that there are certain differences from the usual perceptions of R&D collaborations commonly studied within high-tech sectors such as biotechnology and pharmaceutics. It further confirms the fact that low-tech innovation is based on various knowledge sources from different disciplines (e.g. Hirsch-Kreinsen and Schwinge, 2011).

Research teams have to establish trust and familiarity with low-tech firms, exercise strong managerial and technical capabilities as well as the ability to reach and creatively combine knowledge. NPD process is dynamic in many ways in all three stages (research, development and testing) requiring different degrees of commitment of the stakeholders; university gets more involved in the research phase, while low-tech firms appear to get more involved when practical knowledge is needed. However, changes in culture of both sides seem to be imperative in order to promote fruitful knowledge-intensive collaborations within the low-tech framework. It should be mentioned that GSF project was coordinated by a Marketing and Management Laboratory; this was a strong advantage but not common in research-intensive collaborations. Thus, it is strongly recommended that research teams should include a relevant laboratory when attempting such projects.

However, this paper bares certain limitations. First, no quantitative performance measures are provided to indicate whether the patterns of low-tech /university collaboration identified affect collaborative results in a positive way. It would be also interesting to combine low-tech firms' perspectives and the university perspective within a roader innovation framework.

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