Understanding Industries-Universities Collaboration Tendency, a Swedish-Tunisian comparative study

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Abstract - In order to understand the industries-universities collaboration (IUC) tendency on technology development in developed and developing countries, we analyze the current state of affairs in Sweden and Tunisia. Empirical investigation from 45 companies in both countries was conducted to measure their propensity (actual) and predisposition (in the future) to collaborate with the universities. R&D managers first proposed a categorization of the IUC with regard to the technology development stages. Then, they explained to which extent their industries have been cooperating with the research centers at the universities and their intentions for future partnership. Results show that industries in Sweden are more involved in developing new processes; while Tunisian companies cooperate more with the universities to acquire new knowledge. Swedish companies tend to work on new technologies development as well. Conclusions on tendencies in both countries are drawn and recommendations for the universities are offered.

Keywords – Industry-university collaboration, technology development, research funding, tendency.

I. INTRODUCTION

The university-industry collaborative research environment is evolving and new challenges have been created. Successful projects should interest the industries and be able to demonstrate that they contribute to the company's asset base development. Universities need to engage a further commercially oriented management practices able to deliver the required research outputs to the companies. Thus, it will make added value to industrial technology programs. It is then essential for universities to understand the industries' tendency in technology development research and projects that they collaborate on with universities. In the present study, we try to understand which sort of collaboration industries have or are interested to have with the universities. The aim is to understand industries' tendency in funding technology development research in universities in developed and developing countries. We presume that industries and universities in developing countries, for instance Tunisia, can learn from the experience of the companies and universities in Sweden.

In fact, in an increasingly global networked market for Research and Development (hereafter R&D), it is more important than ever to collaborate. Since the 1980s, an increasingly significant development on the technical

landscape has been the growth of R&D collaboration. There is evidence from a number of studies (e.g. [4, 9]) that suggest the existence of such a trend while R&D collaboration has become a subject of considerable academic interest over the last decade.

From a theoretical perspective, collaboration itself represents a departure from the well-elaborated alternative modes of organizations: market and hierarchy (i.e. the firm) in neo-classic economics. In the R&D context, this option goes against the conventional view that firms are better off if they organize R&D internally; to avoid contractual difficulties in contracting out R&D and to safeguard competitive advantages [2]. The ultimate objective of each technology development research at universities is to influence (hopefully, positively) the way technology is deployed in industry. Obviously, this influence is diminished with the nonattendance of effective collaboration between the university and industry communities. Therefore, universities and industry need to focus on the benefits each party can earn from collaboration. Yet, they need to streamline the negotiations to ensure judicious realization of the research and the development of the research findings.

Furthermore, research centers are growing in importance. Strong environmental forces such as rising global competitiveness, increasing demands for innovation in products and processes, and declining government resources for research accelerate their collaboration growth. In addition, several university-industry centers relationships are precursors to more complex collaborations in the form of consortia involving multiple firms, universities, and other collaborators. A better understanding of University-industry collaboration should help in the design and management of these emerging entities.

Therefore, finding out about industries' favorite collaborative research in technology development is important. Industrial organizations are increasingly concerned by the subject of technical innovation (Dodgson and Rothwell, 1994) as a way to sustain their competitive advantage through the development of improved products and services. Also, they are invited nowadays to improve their process management using technology. These requirements are being supported by the ever increasing complexity of industrial activities caused by rapid developments in technology. In order to support these technological activities, companies are undertaking research programs that are focused on delivering an appropriate technology advantage when

compared to the operations of competitors and which also provide access to specialized knowledge. On the other hand, universities traditionally provide teaching and research services but an increased focus on undertaking research for companies is leading to a requirement to improve the process of research management. This requirement includes a need to increase the likelihood that research proposals that are submitted to industry are successful and result in the award of a contract. More likely, large international companies, such as those from the oil and gas, pharmaceutical and aerospace industries, which traditionally provide significant levels of funding for university research are increasingly accessing universities on a global basis and are less likely to be restricted to traditional academic partners in the home country. This is leading to a much greater level of competition between certain universities in order to gain research funding from these corporations.

Partnerships, at one level, effectively provide universities with needed funding sources as government support for research declines. Companies, in turn, are able to tap into knowledge at the frontier of science and achieve greater flexibility in funding their own research and development efforts [17]. In Sweden, through the numbers of projects run each year, we can see that IUC is expanding. However, in Tunisia companies are rather very cautious. It is then essential for Tunisian companies to apprehend the return of experience from a developed country and for universities to understand the tendency of industries in technology development research and how they can motivate the companies to pool their resources.

To answer these questions, we first review the literature on technology development process and the industries-universities collaboration. Then, we present the methodology adopted for the empirical study. Third, we present the results of the Swedish and Tunisian companies' tendencies. In particular, the results will highlight the major interests of industries for maintaining interaction with universities and funding their research projects, according to their discipline. Finally, we will try to explore the conditions and the reasons for each of the tendencies, draw conclusions and present recommendations for the Tunisian parties.

A. Technology Development

Literature is demonstrating within each new study (Heiskanen *et al.*, 2005; Kulatilaka and Lin, 2006), that industries' competitiveness comes through technology development. However, there is a renewable approach to manage the technology development and to make sustainable competitiveness from there.

Indeed, developing a new technology is fundamentally different from developing new products. A new product developed around the innovation may fail to generate sufficient competitive advantage; from the moment other firms may enter the market and provide similar products quite easily, reducing significantly the

innovating firm's profits. So, because the "research" aspect of R&D is as important as the "development" one [8], firms are invited to be innovative deploying cooperation strategies [14]. There, research and business leaders have a clear imperative and opportunity to introduce changes to improve the effectiveness of new technology development programs.

Few years ago, technology development was only about pure technical point of view and new technology development was defined as "the process by which ideas are converted into a technology base or technology platform" [18]. Nowadays, technology development projects are considered as the "growth engines which provide the platforms for the next generation of products and processes" [14]. Therefore, the expression "technology development" refers now to a special class of development projects where the deliverable is new knowledge, new technology, a technical capability, or a technological platform, or also a new process. These projects, which include fundamental research projects, science projects, basic research, and often technology platform projects, lead then to multiple commercial projects—new product or new process development [14].

Product development, without the needed mindset and orientation, will take longer than it ought to; technology development, under the constraints of short-term business expectations and existing customer needs, will explore neither the scope nor depth of learning needed for significant discoveries [18]. Within the former, technology is the output; for the latter, the input. In order to succeed, programs for technology development must be established within particular context of collaboration, either between technical and business parts, or industries and research centers at the universities.

The fact is that the research ideas, both technical and managerial from the research scientists with the market intelligence and knowledge from business managers and companies are integrated through a set of performance dimensions that are meaningful and make output to both parties [6]. Collateral development of technology is then desirable [14] and although breakthroughs in technology require time and discoveries and innovations cannot be scheduled, industries and universities need to manage resources and programs.

Successful technology development programs can tip the balance of control or influence in the market. However, in order to allow these programs the time and latitude necessary in exploratory investigations, they cannot be tied to immediate market opportunities. These programs need to be guided by the organization's and researcher's knowledge of the longer-range trends, key issues, and dynamics of the business. Market intelligence, vision and research projects are critical ingredients in effective technology development.

The quest for new technology is a search for new knowledge. It is a process of discovery. There is, nonetheless, a more pragmatic side of technology development. Businesses invest money in such endeavors, and expect eventually to gain some tangible benefit that strengthens the health of the business. The challenge rests in how to make progress in such a collaborative learning process (Fig1).

Fig. 1: Technology Development Process

This illustrates the main difficulties in managing new technology development. "Technology" is knowledge, and the process of developing new technology is one of acquiring knowledge, either for a technical aspect or which concerns processes. The second fundamental difficulty in managing technology development is the relative remoteness of the starting point and the ultimate ending points of the entire process [18].

B. Research collaboration

Although there have been many previous studies on research collaboration, comparatively little attention has been given to the concept of "collaboration".

The dictionary definition of collaboration suggests that it is the process by which people/organizations work together to accomplish a common mission. Moreover, as reference [13] describes, it's where groups that disagree, often significantly, come together to identify common interests, define common problems, and seek solutions that reach beyond what any one of them could accomplish on their own.

Research collaboration could be defined as the working together of researchers to achieve the common goal of producing new scientific knowledge.

Scientific knowledge has no real meaning as long as it is not made public and discussed; it simply has to be shared in order to become accepted. The communication of research findings is therefore fundamental to any scientific endeavor, and scientists are constantly engaged in the mutual exchange of information and knowledge [16].

The increasingly interdisciplinary, complex, and costly characteristics of modern science encourage scientists to get involved in collaborative research.

Funding agencies, particularly government agencies, facilitate active research collaboration as part of their funding conditions. Despite the ubiquitous nature of collaboration in science, the benefits of collaboration are more often assumed than investigated [11]. Most studies of collaboration include an underlying assumption that collaborative activity increases research productivity.

One of the most cited literatures in research collaboration is written by [19]. They introduced research collaborations as a particularly informative example of group work and proposed a framework for describing research collaboration that provides guidance to those developing technology to support collaborative work. As Kraut *et al.* in 1988 discuss, figure 2 shows there exist a path that collaborative research typically follows. They proposed that research collaborations progress through three stages –initiation, execution, and public presentation- and that at each stage, activity takes place on two levels- a relationship level and a task level.

Fig. 2: Model of Research Collaboration

In the initiation stage, potential collaborators establish a personal relationship, commit themselves to working together, and plan a project. Their primary goal is to establish an interpersonal relationship based on shared interests.

The central goal of the execution stage of the collaboration is to move from the specification of a research objective through the many and varied tasks that must be carried out to complete the project.

In the public presentation stage, researchers document and disseminate their research. This activity is, again, similar across disciplinary lines.

Contemporary global changes in science and technology were perceived by [7] as the emergence of a new mode of knowledge production. They argued that fundamental changes are taking place in the ways in which scientific, social and cultural knowledge is produced, and that "a distinct set of cognitive and social practices" are emerging alongside the traditional mode. Knowledge production is carried out in non-hierarchical and heterogeneous organizational forms and includes a wider, more temporary and heterogeneous set of players, collaborating on a problem defined in a specific context. This relationship is characterized by close interaction of many players and cooperative efforts constitute one of the

crucial factors of knowledge creation, which is thus becoming more socially 'accountable' [14].

The "go-it-alone" approach to innovation and development is no longer viable. Today the complexity of problems and the need for multidisciplinary approaches requires interaction, the flow of ideas and knowledge exchange. Collaborating and partnering enables innovation ecosystem development and new industry creation [2].

Industrial firms have coped with this demand for 'new' technologies by building up substantial research capacities, but also by research co-operation with universities and other external research institutions. This form of collaborative research involves a deepening of relations and offers greater scope for mutual benefits. These advancements of university-industry partnering occur in specialist areas, where the exchange of knowledge and resources increases and a closer alignment between university research output and its industrial partners' requirements is achieved [4].

C. Research funding

Although there are a number of previously done studies on research funding, but it seems there are no standard modes of funding which can be achieved through the literature. Policymakers and researchers have totally different views on this issue and it can lead us to further researches.

Other researchers generally state that it is noteworthy that very little is known about which of the standard modes of funding research secures the 'best' result in terms of the impact and visibility of the research [1], but since research funding policies and strategies are not among our concerns in this research

As reference [1] state in their study, funding research can be generally divided to external funding and internal funding. This classification seems to be the most accepted and general one among all nations, which regards internal funding to the university owned resources and external funding to any external resources including industry funding, donations, and individual funding.

University research is to an increasing extent funded by industry, and the share of basic funding is decreasing. Through changed funding regimes and changed legislation regarding ownership of research results in many countries, policy-makers aim for a close "triple helix" relationship between universities, governments and industry [5].

Reference [8] mention that while the social contract based on the linear "science push" model of innovation provided basic researchers with considerable autonomy, the new contract, followed by or preceded by changing funding patterns, implies that universities in return for industry and private funds should explicitly address research problems of industrial relevance.

In 2007, reference [15] released a report of their collaborative research with Industry. In this particular

report they refer to funding as "the amount of money provided to perform the multiple tasks of R&D".

D. University-Industry collaboration in different countries

Collaboration with university and other public research organizations seems to have become increasingly important for firms, as the technological inter-discipline and complexity, and the competitive pressures to shorten product life increased [3,9]. In particular, in the new industrialized or developing countries, as their economy and their technological capabilities improve, universities are expected to play an increasing important role in supporting indigenous firms to move into more dynamic and higher-opportunity industries. Indeed, firms were found to achieve higher productivity through university-industry collaboration.

Consequently, following the innovation policies of developed countries, governments in the new developing countries are launching policies fostering university-industry interactions and the development technology. Given the established gap in the innovative capability between developed and developing countries, the process of catching-up in developing and new industrialized countries is a long, difficult and costly process of learning-by-doing and by-interacting [10].

In sum, the review of the literature suggest that in the current economic and technological global environment, there is still scope for developing countries to undertake university-industry collaboration policies aimed at supporting and strengthening catching up. In this regard, understanding the tendency of industries in doing this collaboration in developing countries and comparing them to the ones from developed countries would be a great help for them.

II. METHODOLOGY

A. Exploratory study

At this stage we gathered data from two sources: 1. reviewing the literature and 2. interviewing experts from Lulea University of Technology in Sweden and University of Tunis in Tunisia: 4 experts (2 from Sweden and 2 from Tunisia). Based on in-depth interviews, we have had the 6 categories that relate to the technology development process stages:

- Acquiring knowledge
- Using knowledge
- Developing new ideas
- Developing new technology
- Developing new processes
- Developing new products

According to these categories, the main study after that aimed at finding out industries' tendency to do collaboration with universities. We gathered data in order to understand at which stages of technology development process industries are more likely to conduct collaboration.

B. Main study

Companies that participated in the main study have either collaborated with the universities or have been willing to do so. In-depth interviews were run with managers and R&D managers from 45 companies in both countries (24 from Sweden and 21 from Tunisia).

Interview guide was used to gather information about the level of interest in collaborating with the universities, the importance of the university/industry partnership and the conditions required to succeed such collaboration. Besides, a short additional questionnaire was used to collect data about the company's field of activity, its size and if the company has been collaborating with the universities before or intended to do so.

III. RESULTS AND DISCUSSION

Results from both countries show that nearly all companies that had the profile of big companies, are already doing collaboration with university, in both big and small projects. We found also that some SMEs (2) were doing research collaboration with universities for technology development.

52% of the industries in Sweden are for the automotive sector and Tunisian companies were from different sectors (agriculture, automotive, services) as Tunisian economy is considering only about 2 companies for each kind of the industries that would dispose of budget for research. Industries have shown that they are more interested in acquiring new knowledge and developing new processes than developing new technologies and new products. Swedish companies were also interested in developing new technologies.

Here after, a position for Swedish and Tunisian industries in an associated presentation of the technology development process and the University/industry relationship typology is drawn (Table I).

TABLE I
COLLABORATION FACTORS IMPORTANCE RANKING BY INDUSTRIES

Swedish companies seem to be more oriented to new technologies and processes development in addition to use of the knowledge produced by the universities and developing new ideas with knowledge transfer and cooperative research. Tunisians industries would either be interested in acquiring knowledge and developing new processes in a context of a cooperative research, because they continue to think that universities wouldn't have enough knowledge related to operational business of the companies and then which would be considering real new circumstances for the industries.

Showing that collaboration is very important for both parties, one R&D manager in a Swedish company said: *"There is no defined meaning for success in our job! Researches are always successful, regardless to the results. We do not always need YES answers, sometimes we need to know what we should NOT do. According to that, we try to cooperate with scientists inside and outside the universities, so we can define new methods, products, ideas, and rules. What both parties need is a very close cooperation and same definition for all procedures. Sometimes it happens that we do not understand universities and that's because we did not define everything before"*

On the classification of the main factors that drive the collaboration with the university, companies in both countries have classified the five choices, retained from the literature, differently and this reflects the difference in the research mindset within the two countries (Table II).

TABLE II
COLLABORATION FACTORS IMPORTANCE RANKING BY INDUSTRIES

Rank	Sweden	Tunisia
1	Confidentiality	Confidentiality
2	Licence and patents protection	Communication support
3	Publication protection	Intellectual property protection
4	Communication support	Licence and patents protection
5	Intellectual property protection	Publication protection

V. CONCLUSION

The purpose of this study was to observe and understand research collaboration tendency among universities and industries using technology development as an indicator and to show what companies and universities from developing countries can learn from developed parties.

Within the last decade two main parallel changes have taken place: (i) transformation of society and (ii) transformation of science. These changes have direct impact upon each other, and it is a co-evolutionary process. The traditional modes of organizations characterized by rigid borders between disciplines and isolation from society and industry to some extent have been challenged and alternative relations have taken place [12]. Alliances and networking with the universities and other kind of research centers have become critical factor behind the success and competitiveness of industries. The interactions between knowledge centers and industry have become interactive, which is beyond a flawless flow of knowledge from universities to industry. As these relations have become much more interrelated and non-linear, the forms and patterns of these relations have diversified.

In our study we considered Sweden and Tunisia as two cases. Aim was not to generalise the findings. These latter showed that Swedish companies have larger interest in doing collaborative research than Tunisian industries.

Knowledge production in Sweden shows several aspects of the emergence of a social inter-relationship, as described by [7]. Collaborative ventures are not irreversible phenomena, but will probably gain in strength in the future due to the increase in research costs, for example in clinical testing where costs are spiralling. Knowledge production is less and less a self-contained activity in Sweden. The capacity of knowledge creation in this country depends heavily on the capacity to engage in team-work with increasingly heterogeneous actors, at home and abroad, whereas Tunisia seems to be in more former stage with university-industry collaboration where companies lack confidence in the add value the university may provide them. Recommendations for Tunisian companies and universities would be to engage negotiations in order to come forward the common interest they can cooperate for. Although, the funding provided by small and medium companies can't ensure big projects at once, but can surely work for important and valuable achievement that initiate further development. Wider collaboration with international corporations can be after that achieved.

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