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# EFFECTS OF TECHNOLOGY TRANSFER OFFICES ON CAPACITY BUILDING IN CREATIVITY, INNOVATION AND ENTREPRENEURSHIP

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## Abstract

The article revises the effects of technology transfer offices (TTOs) on capacity building within the university, from the perspective of creativity, innovation and entrepreneurship. The objective of the article is to understand clearly and deeply how TTOs build capacity in creativity, innovation, and entrepreneurship for all the stakeholders, researchers, faculty members, SMEs, incubators, undergraduate and graduate students, and attorneys. Particular focus is given for analysing TTOs activities in order to comprehend the strategy of TTOs in delivering and building capacity for innovative products and services. The author concludes that the universities and TTOs should have a common strategic plan and policy to empower and to increase efficiently and effectively the impacts TTOs activities have on the development of the technology-based innovative products and services.

*Keywords:* Technology Transfer Offices, creativity, innovation, entrepreneurship

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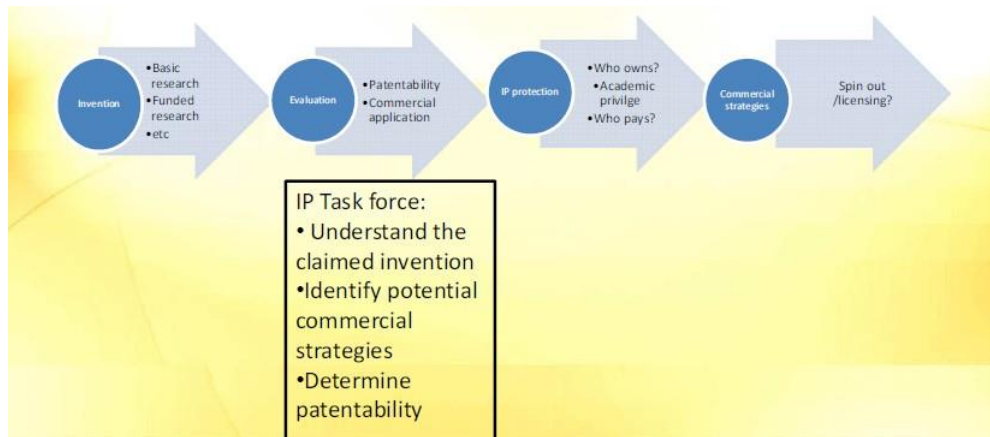
## **1. Introduction**

Due to increasing national and corporate competitiveness in the information age, technology and innovation are becoming increasingly important in the growing number of knowledge-based economies. Although universities have always been traditionally a source of science and technology, especially in the last two decades they have made significant progress and development in their systems to foster and empower technology transfer through collaboration between industry and academics – in other words, technology transferred from universities to industry. Moreover, universities can exert a powerful influence upon national innovation, and university technology transfer offices (TTOs) can be an important influence in encouraging entrepreneurial behaviour in universities and among researchers (Arc, 1999).

According to Brennenraedts et al. (2006), there are ten categories that cause knowledge and technology transfers between universities and firms. These are publications, participation in conference professional networks and boards, mobility of people, other informal contacts/networks, cooperation in R&D, sharing of facilities, cooperation in education, contract research and advisement, intellectual property rights, spin-offs and entrepreneurship. TTO refers to ‘a unit within the university, not a corporation or an entity separated from the university created specifically for the purpose of technology commercialization’ (Carlsson & Fridh, 2002). In terms of the objectives of TTOs, according to Campbell (2007), there are five main goals:

- to contribute to the economy,
- to facilitate research uptake for the public good,
- to develop mutual beneficial ties with industry,
- to motivate and retain academic staff,
- to increase the income of the universities.

In Turkey, there are three types of TTOs; an administrative part of university, a profit or non-profit aggregator type entity (private, public or a hybrid), and a university for-profit separate legal entity/ subsidiary (university spin off, independent venture). The industrial partnership system is described in the following diagram (Hızıroğlu, 2010).



(Source: Hızıroğlu, Ö. (2010). *University Technology Commercialization in Turkey. Les Turkey Conference 2010*)

**Figure 1.** How does Industrial Partnership Systems Works?

In terms of technology commercialization in Turkey, the Association of University Technology Managers (AUTM) definition ([www.autm.net](http://www.autm.net), 2014) clearly defined Technology transfer as “a term used to describe a formal transfer of rights to use and commercialize new discoveries and innovations resulting from scientific research to another party”. Generally, TTO has the mandate of achieving commercial value for industry partnership originating from within the university (Hızıroğlu, 2010).

The Turkish higher education system is comprised of 108 public and 71 private universities (Council of Higher Education, 2014). TTOs are located in different structures; 41 R&D centres in universities, 32 Techno park companies, 20 Small and Medium Industry Development Organizations (KOSGEB), 74 State Planning Organization (DPT), and 2 private companies (Temel, 2012). In spite of these different structures, the main and primary objective is to develop new technology; industries need to have access to the know-how, knowledge, and technological expertise that are produced at universities. This can only be provided via sound collaborations between universities and industry. TTO works closely with faculty and researchers to enable the development, transfer and adoption of inventions and innovations originating at the University, to foster the translation of research outputs into products and services for the benefit of society, and to promote partnerships with industry. While working with industry, TTO assesses the R&D needs of the private sector, bringing researchers and industry together to meet R&D needs and develops links between the two in order to facilitate the technology transfer.

In addition, according to Lin and Ho (2007), TTO provides consultancy services to industries by assessing their R&D needs, bringing together researchers and industry to meet these R&D needs, and matching them with appropriate research projects at the university. The other way TTOs facilitate industry-university partnerships is by matching up industries' needs with those of the university and introducing research projects and findings developed at the university to various companies. TTOs develop project partnerships and collaborations through means such as project bazaars, company visits, and university industry meetings. TTOs also provide assistance to their industry partners who wish to seek external funding for their projects. TTOs assist them in identifying appropriate funding sources and opportunities (both national and international), as well as in proposal development, interpreting guidelines, reviewing and endorsing proposals, and negotiating agreements. In terms of R&D support, TTOs undertake the task of relating research issues with a potential for commercial application to interested parties. Finally, TTOs also support companies by matching the needs of industry by the academics and providing university infrastructure and R&D laboratories in order to ensure the transfer of scientific and technological knowledge and experience (Lin & Ho (2007)).

Several studies have already been carried out regarding TTOs and commercialization of universities. Deeds et al. (1999) studied organizational performance as indicative of the importance of strong skill sets and sufficient staff in order to manage the complex and time-intensive tasks associated with technology transfer practice. Mowery and Sampat (2000) studied the claim that a lack of intellectual property protection was limiting the use and commercialization of university inventions, finding it lacked evidentiary foundation, and that the role of patents and exclusive licenses in facilitating the transfer of university technologies remains poorly understood. Bercovitz et al. (2001) studied the influence of university organizational forms on technology transfer performance. Some researches are related to the measurement of performance on a TTO, like O'Shea et al. (2005) and Thursby et al. (2001). Sampat and Nelson (1999) made a study on the standardization of university technology transfer offices. Markman et al.'s (2005) research topic is entrepreneurship and university-based technology transfer. Also, some researches are related to university policies and initiatives designed to increased commercialization of research activities, such as the study carried out by Rasmussen et al. (2006).

Karjala and Kiskis (2011) assessed the state of US and Lithuanian policies for the intellectual property rights within the university, and producing of proposals for the adjustment of the technology transfer model and increasing its efficiency. Particular focus was given to university technology transfer office practices by observing their practical effects. The authors

concluded that the technology transfer office model may have unexpected secondary benefits for the universities, however these need to be adjusted in order to address the drawbacks and costs of opening a TTO, which are prohibitive for small universities and countries.

Another study on university technology transfer performance found a positive linkage between the number of technology transfer professional staff and licensing activity (Hauksson, 1998; Powers, 2000). Powers (2003) also has academic research on resource effects on the performance of university technology transfer. Harmon et al. (1997), Markham (2002) and Rosenberg & Nelson (1994) have all studied marketing of the TTO portfolio. According to Sieger et al., the TTO must simultaneously evaluate the commercial potential of the technology and decide whether to patent the innovation. Often, interest in the technology by an industry partner provides sufficient justification for filing a patent. In other instances, the TTO must make these judgments before industry expresses an interest in the technology. Furthermore, universities must decide whether to seek global or domestic patent protection. Bayh-Dole (1996) stipulates that faculty members working on federal research grants must disclose their inventions to the TTO.

TTOs must work with scientists and managers or entrepreneurs to structure a deal (Siegel et al., 2000). Scholars from several different academic disciplines and universities have begun to systematically study and document commercial technology transfer and university entrepreneurship (Mowery & Hane, 2014). The characteristics and influence of firms on commercially-oriented channels of technology transfer, such as the licensing or foundation of new firms based on university inventions, appear to differ from those of non-commercial channels of transfer, which include publication of scientific articles and the hiring by firms of students (Mowery & Shane, 2014). Lopez (1998) highlighted some concepts, which, if implemented successfully, can provide more effective research opportunities to higher education institutions. Wright et al. (2004) claimed that while attitudes towards partnerships with the private sector in universities are quite varied and in some cases openly hostile, there is greater acceptance of and a more positive attitude towards entrepreneurship within science departments. On the other hand, in both academia and industry there is a broad agreement in linkage between innovation and TTOs. According to Lin and Ho (2007), innovation is defined as “the process of turning opportunity into new ideas and of putting these into widely used practice”. According to Trott (2012), innovation is not related to idea generation only, it also should include industry needs and expectations. Innovation idea is not independent from industry needs. In universities, TTOs are the main sources of innovation and incubators that most ideas are transferred into the industry. Research of Lin and Ho (2007) is about technology supports, especially in manufacturing and chain management. However, few scholars study on

relationship between R&D, administration and marketing, such as Song and Thieme (2006) and Bendoly et al. (2007). In Turkey, the University Industry Partnership Centre Platform report (USIMP, 2012) stated that the success of TTOs should not only be measured by licensing income, but also by their contribution to industry's performance. A report also reflects that TTOs are not the profitable unit in a university, even in the USA. According to Rampersad et al. (2010), innovation increasingly occurs as a result of unique interaction patterns amongst heterogeneous organizations, including businesses, research organizations, and governmental agencies.

Pisanu and Menapace (2014) have done meta analysis about four key issues of creativity and innovation. The four key issues are: organizational structure, individual characteristics, methods, and content. In terms of TTOs and creativity, intellectual property is another concept. Karjala and Kiskis (2011) article revises the intellectual property rights within the university, from the perspective of facilitating and commercializing faculty creativity. Universities always feel pinched for funds and see the possibility of commercial exploitation of faculty creativity as an important potential supplement to their more traditional sources of income-government, student tuition, endowment income, and funded research. If commercializing faculty creativity were costless, it would be difficult to refute the argument that universities deserve to improve their educational mission with the economic fruits of faculty creativity (Karjala & Kiskis, 2011). On the other hand, according to Karjala and Kiskis, if universities had to rely solely on the commercialized fruits of their research, like private companies, they would be very different institutions. Still, to the extent faculty creativity can be turned into money for the university, it could help funding even more and better research and teaching, including research and teaching in fields other than the one in which the commercially valuable advance was made.

In this study, the main objective is to understand clearly and deeply how TTOs build capacity in creativity, innovation, and entrepreneurship for all the stakeholders, researchers, faculty members, SMEs, incubators, undergraduate and graduate students, and attorneys. More importantly, by analysing TTO activities, this study will also seek to look at the strategy of TTOs in delivering and building capacity for innovative products and services.

## **2. Problem Statement**

In the last 2 decades, universities, especially research universities, have made significant progress and development in their systems to foster and empower technology transfer through collaboration with industry and academics. Hence, they have established technology transfer offices (TTOs) in which many different activities have been arranged to

empower and support the commercialization of academic research, particularly those that are highly technical and innovative. However, their impacts on different stakeholders are not well-defined enough in order to solve inefficiencies and make the system better.

### **3. Research Questions**

There are two research questions;

(a) what is the capacity of TTOs to foster creativity, innovation and entrepreneurship for all stakeholders?

(b) what is the strategy of TTOs in delivering and building capacity for innovative products and services?

These questions are crucial to understand all stakeholders' perceptions about TTOs. According to the University Industry Partnership Centre Platform report (USIMP, 2012) all TTOs management and their roles will be different because of their locations and needs of industry. Also, the capability of each university and its TTOs differs between one city and the other. Especially in Turkey, private universities are more powerful in terms of monetary resources than public ones. According to the report, TTOs should shape their activities according to the industry needs in their location, city or region.

### **4. Purpose of the Study**

Although there are 189 universities in Turkey, TTOs take place in different structures; 41 R&D in universities, 32 Techno park companies, 20 Small and Medium Industry Development Organizations (KOSGEB), 74 State Planning Organization (DPT), 2 private companies (Temel, 2012). According to the report of University Industry Partnership Centre Platform (2012), the responsibilities and tasks are defined as;

- focusing on projects having a chance to gain more money for the university
- generating a role model for the industry
- being aware of the opportunity of researches, projects, licensing etc.
- decreasing the cost and increasing the effectiveness and efficiency of manufacturers
- analyzing and understanding the needs of industry and manufacturer
- demanding creation
- working with regional authorities in order to generate new support mechanisms for industry

The main purpose of this study is to understand clearly and deeply how TTOs build capacity in creativity, innovation, and entrepreneurship for all the stakeholders, researchers,

faculty members, SMEs, incubators, undergraduate and graduate students, and attorneys. More importantly, the strategy of TTOs in delivering and building capacity for innovative products and services is another aspect of this study.

## **5. Research Methods**

By using phenomenological analysis as a research method, the role of TTOs in capacity building of creativity, innovation, and entrepreneurship was analysed and observed for eight weeks in five different universities, in Turkey.

In this study, 5 universities, 192 different participants, who are in details, answered 12 different research questions,

- 54 faculty members,
- 22 graduate students,
- 35 graduate students, 1
- 4 incubators,
- 44 entrepreneurs in the technology parks,
- 16 top managers
- 8 owners of the SMEs in the semi-structured interviews.

The collected data was analysed in Atlas.ti 7 in order to make a more in-depth study. Data analysis of this research included computer assisted coding for deductive reasoning.

## **6. Findings**

The analysis of the collected data show that TTOs play an important and crucial roles in capacity building for creativity, innovation, and entrepreneurship for of the aforementioned stakeholders. However, most of the participants (89%) mention that TTO efficiency and effectiveness changes from one university to another.

More importantly, the effects of TTOs change from one interest group to another. According to the data collected from the participants who are members and researchers of the faculties, the role and activities of the TTOs are not clear and not well known. Additionally, some of them (43%) do not even agree with the existence of the TTOs since, as they point out, the other centres at the university meet the needs of the researchers. A smaller number of the faculty members (12%) see TTOs as commodification of the universities. However, the large number of them (87%) strongly agrees that TTOs open up new dimensions in their research fields since they adapt the subject areas and details according to the needs of the industry.



More critically, those, who are well informed, have applied more patents through the TTOs, and become more aware about the licensing.

From the students' standpoint, particularly most of the undergraduate students (87%) are not aware about TTOs activities comparing to graduate students. However, graduate students take TTOs into consideration from the perspective of incubation, start-ups, and commercialization. A few of them (14%) work closely with TTOs at their universities. Additionally, as some of them (41%) mention that TTOs help them in finding partners in the projects, from the industry as well from the academia. However, a large number of the students (89%) are not happy about the central role of venture capital as a capacity-building activity. More importantly, all the incubators are the graduate students of the university, and they are supported by the managements of the TTOs, yet all of them are not really happy in terms of capacity building in incubation and commercialization, especially in marketing.

From the SMEs aspect, TTOs are very new and are sometimes not taken seriously by the university bureaucracies. Most of the SMEs top managers and owners (89%) do not take TTOs activities very seriously, except those, which they directly support.

In general, nearly all of the participants agree that there should be well-developed, interactive, proactive, and dynamic strategic plans for TTOs in order to improve capacity building. Most (88%) agree that fostering TTOs activities is possible by increasing multifaceted activities, which support each other by doing different projects. The strategy of TTOs in delivering and building capacity for innovative products and services is currently insufficient, so there should be more intensive and extensive programs to increase the impacts of TTOs activities. Hence, the universities and TTOs should have a common strategic plan and policy to empower and to increase efficiently and effectively the impacts TTOs activities on the development of the technology-based innovative products and services.

## **7. Conclusions**

In AUTM's website, technology transfer is defined as "a formal transfer of rights to use and commercialize new discoveries and innovations resulting from scientific research to another party. Universities typically transfer technology through protecting (using patents and copyrights), then licensing new innovations. The major steps in this process include the disclosure of innovations, patenting the innovation concurrent with publication of scientific research and licensing the rights to innovations to industry for commercial development."

It is obvious and inevitable that while TTOs have same definition in the literature, their capacity and diversity of researches about industry and contribution on manufacturers differ from each other in different countries, because all countries have different social, economic

and politic conditions. In Turkey, the University Industry Partnership Centre Platform (USIMP) is the one of the NGOs related to the university & industry partnership and a number of congress and seminars have been held related to this partnership. According to these reports, each university's TTO has different contributions to the industry. In spite of the fact that USIMP concludes that there are four main areas of TTOs. These are; (a) awareness, publicity, exposition and education support, (b) enabling project, consultancy and financial support, (c) licensing, technology transfer and licensing support, and (d) commercialization and entrepreneurship services.

The benefits of "university technology transfer effort", according to the AUTM website, is that "academic technology transfer - the licensing of innovations by universities, teaching hospitals, research institutes and patent management firms - adds billions of dollars" to a nation's economy and create thousands of new jobs. The website goes on to add that these partnerships can lead to the spawning of new businesses, creation of new industries, and opening of new markets. Most importantly, the authors add, "technology transfer from universities to the commercial sector has led to new products and services that improve our quality of life. From new cancer treatments to faster modems, from environmentally friendly metal processing to beautiful flowering plants, technology transfer from academic institutions is advancing the way we live and work."

This definition of TTOs draws attention to the stakeholders and their importance. This study shows that TTOs play important and crucial roles in capacity building for creativity, innovation, and entrepreneurship for all the stakeholders, who are researchers, faculty members, SMEs, incubators, undergraduate and graduate students, and attorneys.

The results of the research generally support the findings of previous authors that are reflected in the literature review. For example, most of the participants (89%) mention that the efficiency and effectiveness of TTOs changes from one university to another. It is obvious that universities in Turkey have intense difference in facility, in the form of not only public or private but also infrastructure and management's perspectives. Moreover, it is inevitable and crucial that the effects of TTOs change from one interest group to another. Although the perception and thoughts of researchers and/or members of the faculties about TTOs, as expected, range from one to another, most of them see TTOs as a chance to open up new dimensions in their research fields. Only 12% regard TTOs as the commodification of universities. More critically, those who are well informed, have applied more patents through the TTOs, and have become more aware about the licensing process. Unlike researchers and/or faculty members, undergraduate students are largely not aware of TTOs and their roles in the university and importance from the vantage point of industry. Only 14% of students work

closely with TTOs. They see TTOs help them to find a project partner from the industry as well from the academia. Most of them are not really happy in terms of capacity building in incubation and commercialization, especially in marketing. Most of SME's owners and top managers are interested in only one aspect, those projects which are directly supported by TTOs.

In conclusion, in order to increase impacts of TTOs, the strategy of TTOs should focus on building capacity to deliver innovative products and services. Hence, the universities and TTOs should have common strategic plan and policy to empower and to increase efficiently and effectively the impacts TTOs activities have on the development of the technology based innovative products and services.

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