Technopolises, SMEs, Funding Agencies and IT– Roles in Engineering Education

Mehmet Önder Efe
Hacettepe University
Department of Computer Engineering
Autonomous Systems Laboratory
Ankara, Turkey
onderefe@hacettepe.edu.tr

***Abstract*—The information technology and the rapid dissemination of knowledge has changed the climate of higher education dramatically. The presence of specially governed technology zones and small and medium enterprises operating in those regions are new actors influencing the teaching models of higher education institutions. This paper discusses how the blending of these can redefine an industry oriented higher education model and what the future projections could be.**

Keywords—Industry oriented learning, technopolises, funding agencies and IT

I. INTRODUCTION

Recently, the number of incubation centers contained in the university campuses has increased dramatically. The driving force for this has been to motivate a productive university-industry-government collaboration. Many Small and Medium Enterprises (SMEs) have benefited from this opportunity and took place in those incubation centers or in technopolises. The funding resource for this is the governmental funding agencies and the number of startup companies in this picture is increasing very rapidly. With this picture in the front, it is inevitable to observe changes in the practices of higher education that stands at the very centre.

The educational practice of higher education foundations and institutions mostly based on in-class lectures and laboratory work in general. This setup has several disadvantages. First and the most important one is that it is not interesting for most of the students and when they graduate, they find a very different world from what they are taught at the university. One remedy to this is the so-called "Cooperative Education" that forces prolonged periods of time at industry.

The gathering of SMEs at technopolises is identified as a perfect habitat for the businesses and institutions in [1], where Science and Technology Parks (STPs) are claimed to provide an environment for technology oriented companies. In [2], the addition of a major university is counted as one of the four factors that are essential for success of a technopolis. Kanhukamwe and Chanakira provide a thorough investigation of the role of university in a technopolis organization, [3]. A report commissioned by Science | Business Innovation Board focuses on several success cases and emphasizes that the gathering of technopolises and universities opens the avenue of benefiting the existence of other, i.e., the professors join projects inside a company and researchers agree to lecture and key outcomes of this partnership are curriculum development, student mobility, academic mobility, R&D collaboration, commercialization of R&D results, entrepreneurship, governance and lifelong learning, [4-5]. Seppo and Lilles, [5], discuss the indicators of university-industry collaboration. The inputs, outputs and the impact of the collaboration are tabulated and a list of critical parameters is given. A thorough investigation of the subject is presented by Oh and Philips, [6], and factors influencing the management performance of science parks are considered in [7], where the major issues are elaborated by considering the North American and European experience.

This paper is organized as follows: The second section discusses the SME models; the third section reveals the technopolis structure in Turkey, the funding opportunities for SMEs are discusses in the fourth section and concluding remarks are given at the end of the paper.

II. SMALL AND MEDIUM SCALE ENTERPRISES

The enterprises at very small level are very dynamic and this business model is preferred mostly by the fresh graduates having a good business solution. Typically these enterprises comprise few employees and physical facilities are limited. The fundamental issues to maintain a SME are

- to reduce the running costs
- to find external funding
- to access expert consultants
- to access experts to prepare project proposals

The model in Turkey considers enterprises having less than 250 employees or annual financial statement less than 25M TRL as a SME, which can be grouped under three subcategories, namely;

- Micro scale business: Less than 10 employees and annual financial statement less than 1M TRL
- Small scale business: Less than 50 employees and annual financial statement less than 5M TRL

978-1-5090-0778-3/16/$31.00 ©2016 IEEE

- Medium scale business: Less than 250 employees and annual financial statement less than 25M TRL. These enterprises are eligible for being accredited as a Research and Development Center.

There are specific funding programs for SMEs of all classes mentioned above to benefit from. A good alternative is to get accreditation from the Ministry of Science, Industry and Technology, which reduces the insurance costs significantly.

III. Technopolis Structure In Turkey

The Technopolis in Turkey have the following characteristic properties:

- Located typically in a university campus
- Includes mainly SMEs
- Includes a branch of the R&D Center of large enterprises
- Fundamental focus is IT related businesses
- Health, electronics, automotive and defense constitute the major fields utilizing IT based solutions
- Main motivation of being in a Technopolis region is to benefit from the advantages in tax system
- Academic staff in within the perimeter of the Technopolis and access to academic consultancy is easy

Typically, being close to a university campus brings several advantages to the Technopolis. Attracting key scholars and talented graduate is the most substantial one, [8].

IV. Funding Opprtunities and Evaluation Schemes

The number of funding opportunities to establish a new business has increased greatly in the last decade. The process is implemented by Turkish Scientific Council (TUBITAK) with several programs.

The one that invites SMEs is the 1507 Program. The projects with duration ≤ 18 months and budget ≤ 500k TRL are considered and a maximum of 75% of the total budget is supported. The program aims at assessing the submissions in three major directions with the qualities listed below. The bullets with "A" get higher grades whereas those with "C" have negative impact on the result. Therefore a project to be sponsored should receive the "A" grade items from the assessors.

A. R&D Content, Technology Level and Innovativeness, [9]

A1. Advances the state-of-the-art technology
A2. Contains novelty worldwide
A3. The outcomes may lead to the development of new standards and regulations
A4. Has potential to lead to new applications or research studies in different technology areas
A5. Remedies the problem of technologic dependence to imported goods
A6. Offers a base product from which new products can be derived
A7. Contributes to the national technologic expertise
B1. Innovative in the local sense
B2. May start new R&D projects
B3. Requires expertise in different technology areas
B4. Enhances the already available technology, method, product, process, technique, system
B5. Outcome is a new product/process for the company
B6. Applies a known method, technique or technology to a new field, sector, product or process
C1. Analytical and/or experimental R&D systematic is insufficient
C2. The goal of the project and the accomplishment criteria of the outcomes are not defined
C3. No potential for technologic applicability and usability
C4. No superiority compared to similar products
C5. Technology transfer, which has little impact on the R&D capability of the company, is stressed
C6. Contains routine activities
C7. Investment for production is aimed
C8. Does not contribute to the R&D capability of the company
C9. Original R&D contribution of the company is limited, R&D activities are outsourced

B. Project Plan and Company Infrastructure

A1. A management plan containing the information flow and decision making processes is available
A2. Necessary experience for the project is available
A3. Company has a R&D department and dedicated personnel and hardware
A4. Internal mechanisms to maintain permanence of experience and know-how are available
A5. Company has a systematic monitoring scheme
A6. Project team contains researchers who has a scientific background
A7. R&D infrastructure and continuity in R&D activities will be gained via the project
A8. Risks are anticipated and precautions were taken
B1. Company is capable of developing/designing new products/processes
B2. Project team contains researchers who have an acceptable background
B3. Project supervisor has the project supervision experience, the team members were involved in such projects in the past
B4. Project plan is realistic and implementable. Work packages (WPs) are acceptable. Connections in between the WPs are defined.
B5. Requested budget items are relevant to the project activities
B6. The duration is suitable when the scope is considered
B7. The responsibility of every team member is defined, man-month values are realistic and the total man-month value of the project is realistic
B8. Critical know-how is available yet some issues are handled via consultancies
B9. A quality assurance system and documentation systematic is available
C1. Backgrounds of the team members are not compatible with the project activities

C2. At least one Bachelor of Science graduate is not available in the project team
C3. R&D infrastructure, software tools, access to knowledge possibilities are not suitable
C4. The technical outputs of the project cannot be acquired by the company
C5. The methods and tools to be used are not compatible with the state-of-the-art technologies
C6. Necessary expertise are not addressed by the project team
C7. Technical/technologic feasibility analysis is missing
C8. Contributions of the project team members are unclear. A task division is missing.
C9. Project activities are not distributed appropriately over the WPs
C10. Requested budget is not justified well
C11. Budget for the requested items is not prepared
C12. Intermediate outcomes and success criteria are not defined. Monitoring is difficult.
C13. WP distribution among the project partners is not appropriate
C14. Project requires special permissions which are absent

C. Economic Aspects

A1. Outcome of the market will be in the global market
A2. Outcome of the project creates a new market or usage area
A3. Rare technology/know-how related to national security will be developed
A4. Natural/limited resources will be used effectively after the completion of the project
A5. Displays potential to initiate technology based companies
A6. Reduces the development gap in between different regions
A7. Creates new employment areas
A8. Contributes to scientific research activities
A9. Contributes to the global competition power of the country
A10. Project activities have positive impact on environment and natural life
A11. The company will be able to become an international partner of larger projects
A12. New R&D partnerships will be obtained via the project
A13. Collaborations within the project will result in the emergence of a sub-industry
A14. Project outcomes contributes to scientific research problems of different sectors
B1. Increases the national competition power of the company
B2. Project outputs will replace a product that was imported
B3. Project outputs will be exportable
B4. Project outputs will be patentable
B5. Project outputs will foster the university-industry collaboration
B6. Outcomes have a positive impact on socio-cultural life
B7. A self-sustained capability to conduct R&D projects will be gained
B8. The outputs do not have a commercial value but they do satisfy the following:
  a.–The outputs are to be commercialized internationally in the future
  b.–The efforts aim at gaining know-how
  c.–The position in the global competition will be maintained
C1. Economic feasibility analysis is insufficient
C2. Market research have not been done appropriately
C3. Though possible, the company did not plan any increase in the quality or productivity
C4. The output will not converge to any kind of economic benefit
C5. Has negative impacts on environment and living organisms
C6. Company, in front of the commercialization of the project results, is not knowledgeable about legal obstacles.

The above scheme contains a typical list of evaluation items which are also used in the projects with special calls. In those cases, the support rate is still 75% but the project budget is typically more than 500k TRL.

An overview of the assessment items emphasizes three main directions, namely;

- R&D Content, Technology Level and Innovativeness
- Project Plan and Company Infrastructure
- Economic Aspects

Considering the setup of the SME level companies, the most important assessment item becomes the R&D content and innovative aspect of the project. The reason for this is the fact that most SMEs have some degree of corporate functions and the plans of the projects from SMEs have very similar characteristics especially in terms of human resources and budget. The crux of the overall scheme is to identify an industrial problem that needs a solution requiring R&D activities. Those attempting to realize hardware are even more interesting from the point of assessor and such projects are more likely to get funding.

A successful proof of the economic benefits of the project is the last, yet not the least, issue. Funding agencies would like to see if there is a positive economic impact of the project. Considering the structure and capabilities of the SMEs, the teams demonstrating the return of the project outcomes, which may be tiny, receive support.

It is seen that there are several instruments to support the entrepreneurs and the question with this picture is the following: How can this picture influence/change the teaching strategies in the higher education foundations? Next section will focus on this.

V. Discussion

The senior design project in engineering education is one opportunity for students to focus on a real life problem. Although this has been an already available instrument of practicing a real problem, the aforementioned opportunities should drive the students propose projects that can receive

funds. Some institutions motivate their students to prepare a project proposal to get some external funding and to establish a SME after graduation. The business models in these cases benefits from the past experiences gained through the senior deign project experience.

Another important opportunity to bring together university and industry is the academic consultancy provided to the companies. The companies receive several funds, they request technical consultancy from academic staff. Within such a framework, many projects for undergraduate students and theses for graduate students can be defined as a work package (WP) of the whole project.

As of 2016, there are 27 technopolis regions, 232 R&D Centers and 190 universities in Turkey. This indicates that the technopolis structure has been adopted in a number of universities. Further to that, the local system allows establishing a Technology Transfer Office (TTO) at every technopolis. TTOs are granted by the government and they establish the link between the academia and SMEs via consultancies. The possibilities reveal a great potential to establish links between university and industry, however, there are steps to take for an effective collaboration. The academic promotion system should consider the joint works of academic staff and technology companies, where the innovative ideas turn into products.

The opportunities offered by IT centric projects and solutions need to be identified carefully as IT businesses benefit from the latest developments very rapidly. The best medium to bring together the entrepreneurs of this field is a technopolis, when managed appropriately; commercially valuable IT solutions can be produced and manufactured. The funding mechanisms for this are diverse in Turkey and a good business plan is very likely to get a governmental support if its presentation emphasizes the key issues listed in the fourth section properly.

VI. Conclusions

This paper discusses the opportunities for the SMEs located at a university campus located technopolis. This setup offers lots of options to students or graduates to become an entrepreneur. IT is a prime area to establish a new business and the trends in IT are more software centric than that in the past. Enterprises having some capability to design hardware are more advantageous as they may manufacture specific solutions and these are the issues that are taught in many higher education foundations. Toward this goal, several institutions offer courses like enterpreneurship, project management, technology management, leadership and so on. The students involved in these programs/courses are very likely to establish a startup company, which very quickly turns into a SME with several projects funded. It should be noted that it is not surprising to see how innovative the students are when they are instructed about startups, project proparation and enterpreneurship.

This paper considers the specific case for SMEs and the funding program that particularly provides resources to SMEs. Key issues of the assessment are discussed and the importance of wording a proper R&D content is emphasized. In spite of the availability of other funding agencies, the role of Turkish Scientific Council is emphasized.

VII. Acknowledgments

The author gratefully acknowledges the facilities of the Computer Engineering Department of Hacettepe University, Hacettepe Technopolis and its Technology Transfer Office.

Special thanks to BBS674 Project Management in Informatic Systems course students and the hosting institute, Informatics Institute of Hacettepe University.

VIII. References

[1] A.N. Link and J.T. Scott, "U.S. science parks: The diffusion of an innovation and its effects on the academic missions of universities. International Journal of Industrial Organization," Vol.21, no: 9, pp.1323 – 1356, 2003.

[2] R.N. Cox, "Lessons from 30 years of science parks in the U.S.A," In J. M. Gibb (Ed.), Science parks and innovation centers: Their economic and social impact. Proceedings of the conference held in Berlin, pp. 17–24, Amsterdam, Elsevier, 1985.

[3] Q.C. Kanhukamwe and M. Chanakira, "Role of universities in contributing towards science and technology park development: A framework of critical success factors," in *Technopolis-Best Practices for Science and Technology Cities* (Eds. D.-S Oh, F. Phillips) Springer, pp.299-311, 2014.

[4] G. Edmondson, L. Valigra, M. Kenward, R.L. Hudson and H. Belfield, "Making industry-university partnerships work," Science|Business Innovation Board AISBL, 2012.

[5] M. Seppo, A. Lilles, "Indicators measuring university-industry cooperation," Discussions on Estonian Economic Policy, Vol. 20, Issue 1, p. 204, January 2012.

[6] D.-S Oh, F. Phillips, *Technopolis-Best Practices for Science and Technology Cities*, Springer, 2014.

[7] Y. Zhang, "Critical factors for science park management: The North American and European experience," Department of Marketing & International Management, Hamilton, New Zealand, 2002.

[8] W.R. Smilor, G. Kozmetsky and V.D. Gibson, "The dynamics of a developing technopolis," The Austin/San Antonio Corridor, 1987.

[9] Turkish Scientific Council (TUBITAK), 1507 Program for SMEs.