The Journal of International Scientific Researches
2018, 3(1)

Barriers to Openness: The Case of Technology Development Zone Companies

Açıklık Üzerindeki Engeller: Teknoloji Geliştirme Bölgesi Firmaları Örneği

Abstract

Open Innovation promises higher outcomes from innovation processes through collaboration and sharing knowledge and the intellectual assets. Inclusion of suppliers, customers or users, partners, and even competitors in innovative processes can help to overcome constraints on internal resources. For ICT companies that operate in eco-systems of technology development zones (TDZ), open innovation approach becomes more critical mostly due to the scale and experience constraints. To understand the barriers of open innovation for ICT firms in TDZs can significantly help strategy and decision makers in designing policies and actions to empower innovation processes in order to overcome these barriers and hence to utilize open innovation for higher competitiveness. Various researchers examined the challenges of open innovation in various contexts, as well as the innovativeness and business performances of TDZ companies. However, there is still a room for research on exploring the dimensions of motives and barriers of open innovation practices of these companies. This study aims to explore the barriers for open innovation in ICT TDZ companies through surveys and in-depth interviews that are carried out in 102 ICT firms in TDZs in Turkey. By applying factor analysis, the main barriers to openness are identified and relationships of these barriers with the company's characteristics explored. Findings reveal that the most frequently perceived constraints are financial and administrative problems.

Kübra Şimşek
Res. Ass., Altınbaş University, Faculty of Applied Sciences, Department of Management Information Systems
kubra.simsek@altinbas.edu.tr

Nihan Yıldırım
Assc. Prof., Istanbul Technical University, Faculty of Management, Management Engineering Department, yildirimni@itu.edu.tr

Article Type / Makale Türü
Research Article / Araştırma Makalesi

Keywords
Open Innovation, ICT Companies, Barriers, Technology Development Zones (TDZ), Science Parks.

Anahtar Kelimeler
Açık İnovasyon, Bilgi ve İletişim Teknolojileri, Engeller, Teknoloji Geliştirme Bölgeleri, Teknoparklar

JEL: O30, L20

Submitted: 12 / 01 / 2018
Revised: 01 / 03 / 2018
Accepted: 11 / 03 / 2018

Öz

Açık inovasyon, işbirlikleri ve bilgi ve entelektüel varlık paylaşımı yoluyla inovasyon süreçlerinden daha iyi çıktılar elde edilmesini sağlamaktadır. Tedarikçilerin, müşteri ya da kullanıcıların, ortakların ve hatta rakiplerin inovatif süreçlere dâhil edilmesi, dahili kaynaklar üzerindeki kısıtların üstesinden gelmeye yardımcı olmaktadır. Açık inovasyon yaklaşımı, özellikle teknoloji geliştirme bölgelerinin (TDZ) ekosistemlerinde faaliyet göstermekte olan bilgi ve iletişim teknolojileri firmaları için, ölçek kısıtları ve deneyim eksiklikleri dolayısıyla daha kritik bir hal almaktadır. Teknoloji geliştirme bölgelerindeki bilgi ve iletişim teknolojileri işletmelerinin açık inovasyon uygulamaları üzerindeki engelleri anlamak, karar vericilere politika tasarımı ve bu engellerin üstesinden gelmek ve dolayısıyla rekabet avantajı sağlamak yoluyla inovasyon süreçlerini güçlendirme hususunda yardımcı olabilmektedir. Çeşitli araştırmacılar, TDZ firmalarının yenilikçilik ve iş performanslarının yanı sıra çeşitli bağlamlarda açık inovasyon uygulamaları sırasında karşılaştıkları engelleri incelemiştir. Fakat özellikle teknoloji geliştirme bölgelerindeki bilgi ve iletişim teknolojileri firmalarının açık inovasyon motivasyon faktörleri ve engellerini incelemek gerekmektedir. Bu çalışma, Türkiye'deki teknoloji geliştirme bölgelerinde bulunan 102 bilgi ve iletişim teknolojileri firmasına uygulanan anketler ve derinlemesine mülakatlar üzerinden açık inovasyona ilişkin engelleri araştırmayı amaçlamaktadır. Faktör analizi uygulanarak, açıklık üzerindeki temel engeller belirlenmiş ve bu engellerin şirketlerin özellikleri ile ilişkileri araştırılmıştır. Bulgular, en sık görülen engellerin finansal ve idari sorunlara ilişkin olduğunu ortaya koymaktadır.

Introduction

As innovation became the key element for nations for economic growth and for firms to gain competitiveness as well as to survive in the face of challenges of the global market, two basic approaches have been developed to foster innovation in the last decades. Open innovation, as the first approach, promises higher outcomes from innovation processes through collaboration and sharing knowledge, information and the intellectual assets (Chesbrough, 2006). Referring to the

theory of constraints and increasing need for maximized utilization of resources, generating innovation through using a firm's own internal resources makes it difficult to survive in the competitive environment no matter how efficient the company works (Chesbrough, 2006; Lichtenthaler, 2008; Van de Vrande et al., 2009). Hence, including suppliers, customers or users, partners, and even competitors opened the way for innovation with scarce internal resources.

Establishment of technology development zones (TDZs) or science parks, as the second approach, enabled the collaboration of academia, technology developer, techno-entrepreneur and government to facilitate innovations. TDZs are the eco-systems that foster technology entrepreneurship and innovative activities in pacing/emerging technologies which may be too risky or not profitable enough to be invested by the regular industry players. Especially in developing countries, in the last decade there is a significant shift to establish TDZs within university eco-systems to construct the institutional infrastructures that are required for triple helix of academic entrepreneurship and catch up with the developed countries. On the other hand, for being the most infectious technology by providing the infrastructural enabling technologies of all other industries, and for being the most agile and adaptable technology by its short product life cycles and short development periods, information and telecommunication technologies (ICT) have the leading role in TDZs.

Hence, to be able to design appropriate strategies to foster open innovation in TDZs, it is important to understand the barriers faced in the current practices of firms operating within them. In the literature, there is an intensive research on the challenges of open innovation in various contexts. TDZs are also researched in terms of their innovativeness and business performances. However, there is still a room for research on exploring the levels and constructs of open innovation practices in the companies that are located in TDZs.

This study aimed to explore the practices and basic constructs of barriers for open innovation in TDZ companies through carrying out surveys and in-depth interviews in 102 ICT companies of TDZs in Turkey. After briefly reviewing the relevant literature on open innovation and technology development zones, the current situation of TDZs in Turkey is presented. The section on the methodology that explains the data collection, survey method, and data analysis, is followed by findings and conclusion sections.

1. Literature on Open Innovation

There are now two paradigms on converting an invention into value: Vertical Integration (traditional closed innovation paradigm) and open innovation (OI) paradigm. The traditional paradigm is based on conducting all steps of innovation process within the firm, relying on internal R&D; it internalizes and controls both invention and commercialization entirely (Chandler, 1990). R&D labs are considered as a strategic asset that created entry barriers for their potential rivals. OI paradigm, however, assumes that any firm cannot afford to make innovations by performing R&D and marketing activities single-handedly (Chesbrough, 2006). Although, many firms achieved commercial successes in the 20th century, closed innovation paradigm has become obsolete in the 21th century owing to a number of erosive factors such as the increasing availability and mobility of skilled workers, the venture capital market, external options for ideas sitting on the shelf, the increasing capability of external suppliers (Chesbrough, 2003a). Before Henry Chesbrough (2003a) has conceptualized OI, the positive impact of openness on innovativeness and competitiveness had already been claimed (Trott & Hartmann, 2009) in terms of providing quality information from outside the firm (Carter & Williams, 1959) and prominence of external linkages in information acquisition from outside the firm due to working through gatekeepers (Allen & Cohen, 1969). This approach handles R&D as an open system (Chesbrough, 2006) and underlines that precious ideas can come from inside or outside the firm and can go to market from both sides as well (Trott & Hartmann, 2009).

One of the clearest definitions of OI is "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation,

respectively" (Chesbrough, 2006). Hence, OI has two facets that are called as technology exploration (outside-in) and technology exploitation (inside-out) (Van de Vrande et al., 2009).

- Inbound open innovation or technology exploration refers to innovation activities to capture and benefit from external sources of knowledge to leverage current technological developments. As shown on Figure 1, this approach has three practices as venturing, outward licensing of intellectual property, and the involvement of non-R&D workers in innovation initiatives.
- Outbound open innovation or technology exploitation suggests that firms can look for external organizations, whose business models are suitable for commercialization of a given technology. The main practices of Technology Exploitation are customer involvement, external networking, external participation, outsourcing R&D and inward licensing of IP (Van de Vrande et al., 2009).

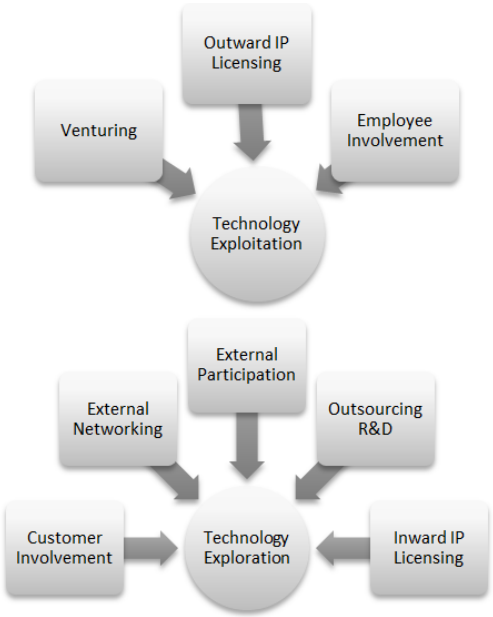

Figure 1. Most Frequent Technology Exploitation and Exploration Practices, Van De Vrande Et Al. (2009)

In a full OI context, organizations would combine and capitalize both technology exploitation and technology exploration practices (Figure 1) to get maximum value from their technological capabilities and complementary competencies of others (Chesbrough & Crowther, 2006; Lichtenthaler, 2008; Van de Vrande et al., 2009).

As a complementary classification of OI practices, Chesbrough and Brunswicker (2013) differentiate between non-pecuniary and pecuniary mode of OI (Figure 2). When the knowledge flows are non-pecuniary, there is not direct financial compensation and reward regarding it for sourcing external knowledge without financial reward and compensation. However, in a pecuniary mode of inbound OI, a firm reveals knowledge freely via donations.

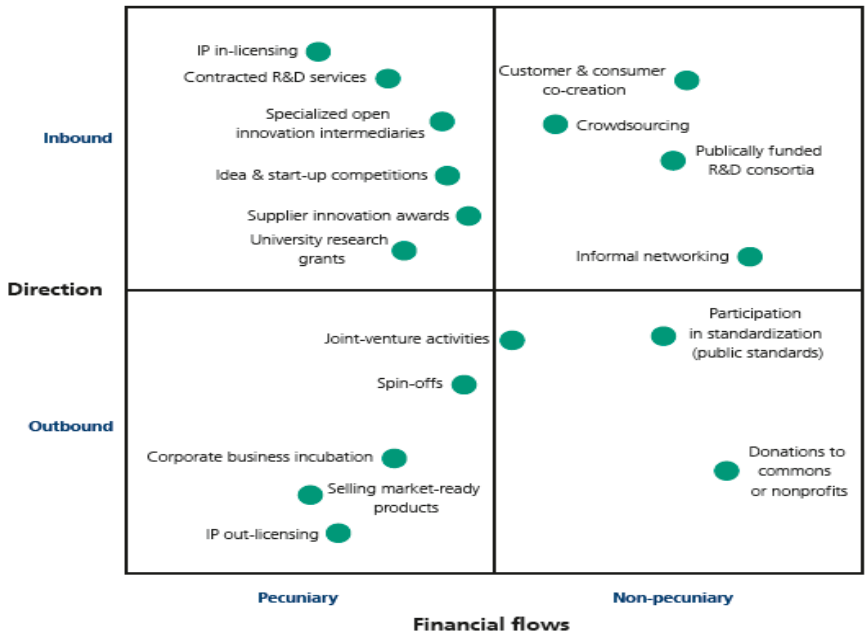

Figure 2. Classification of Modes of Open Innovation, Chesbrough And Brunswicker (2013)

1.1. Open Innovation in SMEs

SMEs are the largest number of companies in an economy, but they are under-researched in the OI literature (Gassmann et al., 2010). Having an extraordinary ability to survive and increase their performance even in economic crisis and contributing to economic and social development through their economic diversification and rapid structural changes (Hamdani & Wirawan, 2012). SMEs and start-ups have a crucial role in the economic development of both developed and developing countries (Kaufmann & Tödtling, 2002; Ashrafi & Murtaza, 2008). They also differ from larger companies by the ways they innovate and utilize OI practices (Parida et al., 2012; Brunswicker & Ehrenmann, 2013) since they have advantages like size, focus, business specialization, entrepreneurial personnel, dynamic management style, less bureaucracy, better internal communications, strong relationship with customers as well as speed in reacting, decision making and taking actions for utilizing the trends rapidly if entry costs are low enough for them while their larger counterparts were restricted to enter small markets because of higher constant costs (Scozzi et al., 2005; Chesbrough, 2010; Hutter et al., 2013). Thus, all these characteristics create an innovation supporting culture in SMEs (Laforet, 2008).

Table 1. Main Modes of Open Innovation in SMEs Krause Et Al. (2012)

Open Innovation Type	Description
Platforming	Providing a base product to which customers can extend the capabilities of the product and add value to all involved (such as iPad and Apple store applications).
Idea Competitions / Challenges	Rewarding individuals, groups or companies for providing ideas to solve specific stated problems in the form of a competition or challenge.
Customer Immersion	Observation of the customer-product interaction process to further enhance products or services.
Collaboration	Developing new products, services or other capabilities through collaborating with customers, suppliers, or other 3rd parties.
Innovation Networks	Incorporating the input from a network of contributors such as innovation hubs, advisory boards and science centers.
Innovation Intermediaries	A company which focuses its business on helping other companies implements various facets of open innovation.
IP or Tech In-Licensing or Acquisition	Licensing or buying patents and technology and incorporating it into your organization.
IP or Tech Out-Licensing or Selling	Licensing or selling your own patents and technology to other organizations or spinning out a new company.

Lead Users	Identifying innovations added to your product by users for their own use and then incorporating the ideas back into your product.

The main modes of OI in SMEs had been classified (as shown in Table 1) as platforming, idea competitions and challenges, customer immersion, collaboration, innovation networks, innovation intermediaries, IP or technology in-licensing or acquisition, IP or technology out-licensing or selling, and lead users (Krause et al., 2012).

According to Van de Vrande et al. (2009), SMEs are increasingly implementing OI practices in their innovation process by primarily benefiting from informal and unstructured methods that do not require substantial investment, like technology exploitation activities through initiatives and knowledge of their non-R&D workers. On the technology exploration side, they make the customers involved in innovation process and make use of external networking to acquire knowledge. However, activities which require substantial investment, formalized contracts, and structured innovation process for risk management like outward and inward IP licensing, external participation, and venturing activities are rarely practiced by SMEs.

However, some studies suggest that SMEs face constraints when they engage in OI. Since open innovation paradigm has its roots in knowledge transfer theory, the barriers for knowledge transfer is also valid for OI. According to Simonin (1999), partner specific variables, such as cultural and organizational distances, are related to knowledge ambiguity that in turn negatively affects knowledge transfer, while "not invented here syndrome (NIH)" stands as a barrier for external knowledge acquisition (NIH is the "tendency of a project group of stable composition to believe it possesses a monopoly of knowledge of its field, which leads it to reject new ideas from outsiders to the likely detriment of its performance (Katz & Allen, 1982). Similarly, cultural and organizational problems constitute the basic constraints to OI (Van de Vrande et al., 2009) together with the lack of internal commitment (Chesbrough & Crowther, 2006). While NIH syndrome relates to negative manners towards technology exploration, companies may also have negative manners towards technology exploitation, leading to only used here (OUH) syndrome (Herzog & Leker, 2010).

According to the resource-based theory of competitive advantage, resources of the companies are among the most important determinants of a company's success (Grant, 1991). Hence, limited resources (human and financial) as well as the immature organizational structure and competencies of SMEs due to their smallness and newness (Table 2), lead to lack of strong resistance to harsh competition and environmental conditions that result in suffering from even minor inefficiencies (Narula, 2004; Gruber & Henkel, 2006). That is why the medium sized enterprises are more successful in practicing OI (Van de Vrande et al., 2009).

Table 2. Key Challenges for New Venture Management, Gruber & Henkel (2006)

Newness of the Firm	Smallness of the Firm
Unknown organizational entity	Very limited financial resources
Lack of trust in the abilities and offerings	Few human resources
Reliance on social interactions among strangers	Lack of critical skills
Lack of exchange relationships	Limited market presence
Lack of internal structures, processes/routines	Limited market power, disadvantage in negotiations
Lack of experience	
Lack of historical data for planning purposes	

These structural deficiencies of SMEs regarding OI, also, negatively affect absorptive capacity, absorbing external ideas and technologies, partnerships and intellectual property rights (Chesbrough, 2010) that are necessary for technology exploration to recognize the value of new, external information, assimilate it, and apply it to commercial ends (Cohen & Levinthal, 1990). Chesbrough (2010) argues that SMEs do not have the ability to support dedicated personnel and resources to identify useful external knowledge as their personnel lacks the sufficient scientific background to understand, absorb and exploit the scientific discoveries and technologies, which are developed at research laboratories, universities or large companies. Moreover, SMEs are frequently

seen as unattractive partners by universities and research organizations which mostly prefer to collaborate with larger and well-known enterprises (Chesbrough, 2010).

However, SMEs and start-up companies located in TDZs have an advantage of mostly being established by techno-entrepreneurs who have advanced understanding of technology and the capability and skills to develop it. They also operate within a triple helix eco-system including universities and research institutions that facilitate learning and utilizing new technological and scientific developments. Spithoven et al. (2010), on the other hand, state that SMEs can get over their weaknesses for practicing OI, through benefiting from third party technology intermediaries. TDZs, in this context should be replacing these technology intermediaries by performing complementary R&D activities such as business intelligence, technology road mapping, enabling networking by identifying potential partners, or facilitating collaboration with external partners. However, the difficulty of making partnership with others is still valid for SMEs in TDZs. Adapted from Rahman & Ramos (2013), Table 3 shows the constraints of SMEs in practicing OI in four aspects; human aspects, general constraints, policy constraints and competition.

Additionally, Table 4 lists other barriers of SMEs for practicing OI from the study of Krause et al. (2012) that demonstrated organization/culture and administration are the main barriers for South African SMEs, while intellectual property was not rated as a major barrier although it has been mentioned in the literature.

Table 3. Open Innovation Constraints in SMEs, Rahman & Ramos (2013)

Human Aspects	General Constraints	Policy Constraints	Competition
Scarcity of skilled manpower	Lack of market demand (Low purchasing power of customer)	High cost of open innovation	Increase quality of product/ service
Scarcity of non-skilled manpower	Lack of skilled manpower	Lack of financing	Increase product differentiation
Low image of the profession	Too expensive manpower	High economic risk	Look for market niches (demand)
Low image of the sector	Lack of quality management personnel	Organizational rigidities	Increase marketing activity
Low image of the type of enterprise	Problems with administrative regulations	Government regulations	Reduce costs of production
Wage levels too expensive	Problems with infrastructure (e.g., electricity, gas, communication, etc.)	Lack of customers' responsiveness	Forming strategic partnerships
Unpleasant work	Problems with access to finance (other than interest rates)	Lack of knowledge to use new technology	Reduce prices (prices of products/ services)
Unpleasant working conditions	High interest rates	Lack of information on market	Increase working hours
	Lack of knowledge in implementing new form of technology		Look for other foreign markets
	Lack of knowledge in implementing new form of organization		Reduce production
	Difficult to protect intellectual property		

Table 4. Barriers to Using Open Innovation in The Organization for SMEs, Krause Et Al. (2012)

Barriers to OI	Explanation
Finance	Obtaining financial resources
Resources	Cost of innovation, time needed, and human resources needed
Organization/ culture	Balancing innovation and daily tasks, communication problems, aligning partners, organization of innovation
Knowledge	Lack of technological knowledge, lack of competent personnel, lack of legal/administrative knowledge
Marketing	Insufficient market intelligence, market affinity, marketing problems with new products
Administration	Bureaucracy, administrative burdens, conflicting rules
Quality of Partners	Partners does not meet expectations, deadlines are not met
Idea Management	Employees have too many ideas, no management support, no formal process for

	innovation
Customer demand	Customer demand too specific, innovation appears not to fit the market
Commitment	Lack of employee commitment, resistance to change
Intellectual Property Rights	Ownership of developed innovations, user rights when different parties corporate
User acceptance	Adoption problems, customer requirements misjudged
Competent employees	Employees lack knowledge/competences, not enough labor flexibility
Other	

Savitskaya et al. (2010) also explored open innovation barriers for inbound and outbound open innovation in China as shown in Table 5.

Table 5. Barriers to Inbound and Outbound Open Innovation, Savitskaya Et Al. (2010)

Barriers to Inbound Open Innovation	Barriers to Outbound Open Innovation
Not-invented-here (NIH) syndrome	Not-sold-here (NSH) syndrome
No adequate technologies on offer	Complexity of IPR, fear of infringements
Takes too much time/resources	The difficulty of finding buyers
Fear of losing own innovation ability	Lack of marketplaces for technologies

1.2. Science Parks, Technology Development Zones and Open Innovation

According to WIPO (World Intellectual Property Organization) (2014), Technology Development Zones refer to a site where academic, economic and social structures become integrated to act as incubators. They are, like science parks, structures to support the development of entrepreneurs, the region and the country through commercialization of knowledge by enabling collaboration and resource sharing among different stakeholders. Core stakeholders of science parks are companies, universities, government, angel investors and venture capitalists, and research laboratories (Narasimhalu, 2013). According to Research and Investigation Report (2009), all denominations were formed in science parks by combining concepts such as "technology", "science", and "research" with concepts representing space such as "park", "center" and "city". R&D and innovation-based entrepreneurs are indispensable for science parks. Various support mechanisms are available in the majority of science parks. However, the synergy of the environment is an important cause of attraction (Research and Investigation Report, 2009).

Science parks procure a shared area for large firms, small and medium enterprises (SMEs) and start-up companies. Narasimhalu (2013) identifies the critical success factors of science parks as: (a) They can provide flexible physical resources by allowing their lessees to relocate or leave their places immediately and enabling various configurations of place which allow a firm to start a new life as a start-up, expand into a SME, and perhaps grow into a large company in the same place. (b) Start-ups and SMEs absolutely need coaches, mentors and workshops which are managed by science parks. (c) Science parks are one of the most appropriate candidates as a multifaceted connecter for open innovation across large companies, SMEs, start-ups, universities and research labs. Various types of networking sessions that are organized by science parks provides flow of human capital as well as opportunities for in licensing and out licensing of IP (Narasimhalu, 2013).

1.3. Technology Development Zones in Turkey

Incubators/science parks are believed to be well-suited especially for countries that have rather weak national innovation systems (NIS) (Colombo & Delmastro, 2002) like Turkey of which NIS can be characterized by low technology intensity and low level of interaction. Although TDZs basically formed to deal with such shortcomings through networking, unlike many developed countries, Turkey has met with the concept considerably late. State Planning Organization (SPO) was appointed to establish science parks (Research and Investigation Report, 2009) in 1989, but the legislative regulation to establish them was effectuated in 2002 via The Technology Development Zones Implementing Regulation (TGBD, 2015). TDZs are Science Parks like institutions established by Small and Medium Size Industry Development Organization (KOSGEB) in Turkey. Universities

and many industrial enterprises have started to develop science parks (Yalcintas, 2014) after 2003 with expectations to create competitive advantage by developing technology-based industries for the Turkish economy that was still relying on traditional production based on cheap labor. 59 science parks were established by 2014 in Turkey. Figure 3 and Figure 4 show the number of TDZs established and the number of firms which operate in them (SAGM, 2014).

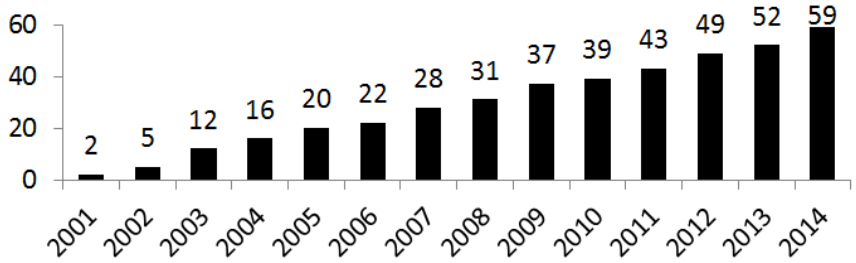

Figure 3. The Number of Technology Development Zones in Turkey-2001-2014 (SAGM, 2014)

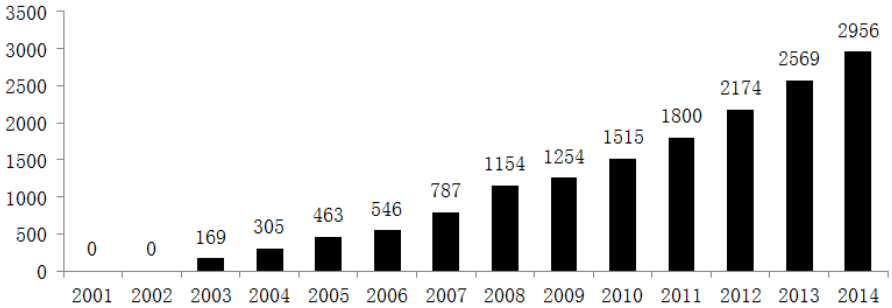

Figure 4. The Number of Firms in Technology Development Zones in Turkey (2001-2014) (SAGM, 2014)

2. Materials and Methods

2.1. Research Framework – Theory and Hypotheses

The main objective of the study is to explore the current open innovation practices and understand the barriers for ICT start-up firms and SMEs that are practicing open innovation and try to define necessary actions and strategies to enhance open innovation practices in TDZs in Turkey. Because the barriers to open innovation are multidimensional and intangible, comprehensive measures that are collected from the related literature are adapted to this research. Items concerning constrains to open innovation are adapted from the studies of Savitskaya et al. (2010), Krause et al. (2012) and Rahman & Ramos (2013). To this end:

- The most and least preferred open innovation practices are identified.
- The factors that act as barriers for the practices of open innovation are explored by factor analysis.

Based on the factors found, relationships between the company characteristics and barriers to open innovation are examined. Research hypotheses regarding these relationships are given below.

H1: Each factor that acts as a barrier to open innovation significantly differ by the experience (age) of the firm.

H2: Each factor that acts as a barrier to open innovation constraints significantly differ by the type of the firm.

H3: Each factor that acts as a barrier to open innovation significantly differ by the scale of the firm concerning number of employees.

H4: Each factor that acts as a barrier to open innovation differ by the scale of the firm concerning annual turnover of the firm.

H5: Each factor that acts as a barrier to open innovation significantly differ by duration of practicing open innovation.

Given the research hypotheses, our research model is showed as in Figure 5.

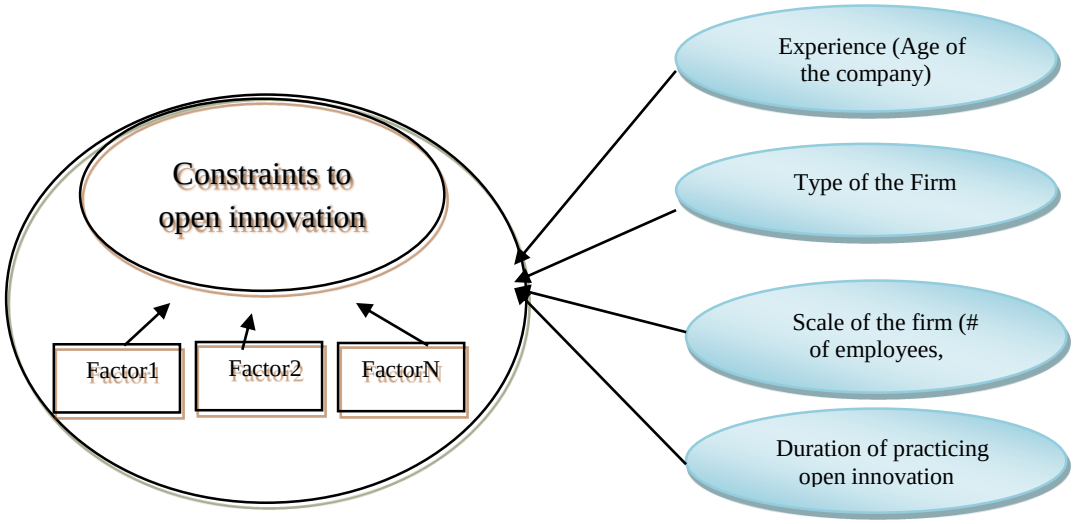

Figure 5. Research Model

2.2. Data Collection and Survey Design

Data is collected with a survey that was developed in the light of the information gathered from the literature. In Table 6, the references which questions that were derived from are listed in details.

Face validity of the survey is provided by the reviewers from ITU Technology Transfer Office experts, and the required revisions are done on the questionnaire (scales are edited, the question regarding intellectual property rights is added, options are revised and some ambiguities are corrected). Then, a pilot study is conducted with selected companies that are located in Istanbul Technical University- ITU ARI Teknokent - Technology Development Zone. The survey questionnaire is finalized by the feedback from the pilot study and e-mailed to 515 firms of 41 science parks in Turkey.

102 firms responded to our survey (response rate is approximately 20%). All participants are from executive level (owner: %56, manager: %35, specialist/engineer: 6.9% or administrative/support staff: %1.8). 95 of the 102 companies are independent companies while 7 respondents are subsidiaries of an international company. A company may have more than one activity area; hence more than one option could be selected by respondents when replying to the "activity area" question.

With the volunteering respondents from ITU ARI Teknokent, we had a face-to-face interview about the insights of their responses.

The statistical analysis methods that are used in the research are descriptive statistics, reliability analysis, factor analysis, difference tests, and correlation analysis. Difference tests were performed by using t-Test and ANOVA. Data processing is performed using the SPSS Software, version 20.0.

The survey consists of 30 questions in four sections: general information-demographics/characteristics/business performance of the respondents (fill in the blank), innovation types and innovation performance from Oslo Manual (2005) and CIS Survey (2010), open innovation practices and barriers to openness (Chesbrough, 2006; Van de Vrande et al., 2009; Krause et al., 2012; Chesbrough & Brunswicker, 2013; Rahman & Ramos, 2013). Barriers to open innovation items are operationalized by means of 5-point Likert scale ranging from "never" to "a great deal

The general reliability of the survey questions on the barriers for open innovation tested by Cronbach's alpha model (Cronbach, 1947) that is used as a lower bound estimate of the reliability and found to be 0.859. According to Nunnaly (1978), however, 0.7 is an acceptable reliability coefficient but some studies in the literature use lower thresholds. In this case, the data reliability is found to be valid for the study.

78 of respondent companies operate in software (76.5%) in the ICT sector. Their distribution by industry segments are as: 25.5% in hardware business, %10,8 in digital mobile media, %21.6 in telecommunication technologies, 12,7% in audio and voice processing technologies and %26,5 in other ICT areas. Almost %50 of companies is established between the years of 2010-2014, %27 between 2005 and 2009 and %20 between 2000 and 2004. More than half of the participating firms (54%) have less than 10 employees and only 7% of them have more than 250 employees. Approximately 63% of the firms have annual turnover less than 1 million TL (approximately 350.000 US dollars) while only 3% have an annual turnover higher than 40 million TL (approximately 14 million US dollars). Therefore, it can be said that the data is collected from start-ups and young SMEs in the Turkish ICT industry.

Table 6. Linkages between Survey Questions and Literature Review

Question	Scale	Question Number	Source
Foundation Year/Age of the company	Nominal	G1	Demographics, Gruber & Henkel (2006).
Science Park the company located in	Nominal	G2	Demographics
Target Market , Activity Area	Nominal	G3, G4	Spithoven et al. (2010), Laforet (2008).
Firm Type	Nominal	G5	Laforet (2008)
Scale of the company by Employee Number and Annual Turnover	Ordinal	G7, G8	Rahman & Ramos (2013), Hutter et al., (2013) Van de Vrande et al. (2009)
Sensitivity to Protection of IPR	Scale	G9	Expert from ITUNOVA TTO
Type of product innovation	Nominal	I1	CIS Survey (2010)
Importance of collaboration partner	Scale	I7	Krause et al. (2012)
Open Innovation Knowledge of Respondent	Scale	O1	Krause et al. (2012)
Open Innovation Knowledge of Organization	Scale	O2	Krause et al. (2012)
Open Innovation Practices	Scale	O3	Krause et al. (2012)
Duration of practicing open innovation	Ordinal	O4	Chesbrough & Brunswicker (2013),
Intensity of open innovation implementation	Scale	O5	Chesbrough & Brunswicker (2013),
Investment on Open Innovation	Ordinal	O7	Rahman & Ramos (2013)
Sales revenue from open innovation	Ordinal	O8	Rahman & Ramos (2013)
General constraints on open innovation	Scale	O10	Krause et al. (2012)
Constraints on inbound open innovation	Scale	O11	Savitskaya et al. (2010)
Constraints on outbound open innovation	Scale	O12	Savitskaya et al. (2010)
Constraints of human resources on open innovation	Scale	O13	Rahman & Ramos (2013), Expert from ITUNOVA TTO

2.3. Factor Analysis Methodology

Principal component analysis, since it is the most used approach among all factoring techniques, has been preferred for factor analysis. Additionally, Varimax technique to perform orthogonal rotation has been preferred because it is easy to interpret and provide almost the same results with oblique rotation.

Before determining the construct validity of the scale, whether it is appropriate for factor analysis has been measured by Kaiser-Meyer-Olkin Measure of Sampling Adequacy and whether correlation matrix is equal to unit matrix has been measured by Barlett's Test of Sphericity. High KMO value indicates that each of the variables can be predicted by other variables in the scale.

The descriptive statistics regarding the factors are calculated. After the exploratory factor analysis, the identified factors that are named in accordance with their content, and their components from questionnaire (items). Internal consistency reliability of the survey is tested by using Cronbach's alpha coefficient method.

Anti-image correlation matrix has been investigated before performing factor analysis. Scree plot and variance explained by factors have been calculated in order to decide the numbers of factors, and it was decided to scale 6 factors.

2.4. Relationships – Contingency between Company characteristics and Factors

In the light of contingency theory of management, hypotheses on the significant differences in factors that were identified by Factor Analysis by company characteristics are tested by difference tests (t-test, ANOVA Test).

3. Results

As explained in the methods section, innovativeness levels, open innovation practices and factors that act as barriers to implement open innovation methods in respondents companies from TDZs are reported in previous sub-sections.

3.1. Innovativeness of the Respondent Firms

84.3% of the respondents introduced both product and process innovation between 2012 and 2014, while 9.8 % introduced only product innovation and 4.9 % of them introduced only process innovation. Hence, it can be said that these firms have been innovative.

When we look into the enablers of these product innovations (Table 7), 89 % of the participating companies developed most of their new products or services in-house, only 22% of them collaborated with others in the innovation process. Others include independent enterprises and other parts of the respondent's enterprise group such as subsidiaries, sister enterprises and institutions as universities, research laboratories and non-profit organizations. Only 6% of the firms make product innovations by adapting or modifying goods or services originally developed by other enterprises or institutions. Hence, the respondents mostly prefer to develop new or significantly improved products themselves.

Table 7. Developers of Product Innovations

Enterprise by itself	**Frequency**	**Percent**
Yes	91	89,2
No	11	10,8
Total	102	100,0
Enterprise collaborating with other enterprises or institutions	**Frequency**	**Percent**
Yes	22	21,6
No	80	78,4
Total	102	100,0
Enterprise by adapting or modifying goods or services originally developed by other enterprises or institutions	**Frequency**	**Percent**
Yes	6	5,9
No	96	94,1
Total	102	100,0
Other enterprises or institutions	**Frequency**	**Percent**
Yes	3	2,9
No	99	97,1
Total	102	100,0

Novelty degrees of these product innovations are shown in Table 8. If a company introduces an innovation onto its own market before competitors, that innovation is new to market of the company. Also, if a company introduces an innovation that is already available in its own market, the innovation is only new to company. Between 2012 and 2014, approximately 74 % of the respondents generated product innovations that are new to market, and approximately 54 % of the companies made product innovations that are only new to the firm. Hence, it can be said that the majority of the respondents are producing new-to-market innovations.

Table 8. Novelty of Product Innovation

New to your market	**Frequency**	**Percent**	**New to the firm**	**Frequency**	**Percent**
Yes	75	73,5	Yes	54	52,9
No	27	26,5	No	48	47,1
Total	102	100,0	Total	102	100,0

The significance levels of contributions made to the process of innovation were also asked to respondents on 5-Likert Scale where 5 implies "very important" and 1 implies "unimportant" that

are shown in Table 9. The most important collaboration partners are employees while development agencies are the least important.

Table 9. Significance Level of Contributions Made to The Innovation Processes (N=102)

Collaboration Partners	Mean	Std. Deviation
Employees	4,55	1,030
Customers	4,21	1,047
Suppliers/ Stakeholders	3,22	1,122
Universities and Other Academic Institutions	3,18	1,338
Competitor Companies	3,00	1,160
Technology Transfer Offices	2,92	1,377
Development Agencies	2,67	1,374

3.2. Open Innovation Practices of the Respondent Firms

How knowledgeable are the respondent firms about open innovation (OI) is questioned (on 5-Likert scale where 5 stands for "agree strongly" and 1 stands for "disagree strongly") in individual and organizational context. The responses to the questions on implementation of OI; "compared to three years ago, our organization is implementing open innovation more intensely" and "compared to three years ago, management support to open innovation has increased" are shown in Table 10. Respondents believe that they are more knowledgeable about open innovation than their organization. Management support is seen as satisfactory and implementation of OI is increasing.

Table 10. Open Innovation Knowledge and Practice of The Respondent Firms

	N	Mean	Std. Dev.
I am knowledgeable about open innovation	102	3,74	1,004
Organization is knowledgeable about open innovation	102	3,21	1,056
Implementing OI more intensely	102	3,76	1,085
Management Support to OI	102	3,70	1,070

For the question about the firms' OI practices, 5-Likert scale was used; 5 implies "we use already, 4 "we are about to use/planning to use", 3 "implementation would be good", 2 "we do not consider to use", 1 "we never use". The options of related question were taken from the study of Krause et al. (2012) on the practices of SMEs.

As shown in Table 11, Non-pecuniary open innovation activities are more popular among ICT Companies in TDZs in Turkey. While the customer immersion, collaboration, and lead users are the most preferred OI practices, idea competition is the least preferred OI practice with the highest standard deviation of about 1.17.

Table 11. Open Innovation Practices (N=102)

Open Innovation Practices	Mean	Std. Deviation
Customer Immersion (NP)	4,34	,884
Collaboration (NP)	4,12	1,008
Lead Users (NP)	4,10	1,067
Platforming (NP)	3,79	1,084
Innovation Network (NP)	3,53	,972
IP or tech-out licensing or selling (P)	3,53	,951
IP or Tech-in licensing or acquisition (P)	3,50	1,150
Innovation Intermediaries (P)	3,34	1,029
Idea competitions/ Challenges(P)	3,20	1,169

For how many years the companies have been practicing OI was asked. Table 12 shows the frequencies and percentages regarding the duration of practicing OI. 37.3% of them have been practicing OI for less than 1 year, while about 5% have been practicing for more than 10 years. (Since 5 of 102 respondent companies do not use any OI practices, they did not select any option in this question).

Table 12. Duration of Open Innovation Practices

	Frequency	Percent
We do not use	5	4,9
Less than 1 year	38	37,3
1-3 years	32	31,4
3-5 years	16	15,7
5-10 years	6	5,9
More than 10 years	5	4,9
Total	102	100

3.3. Factor Analysis for Validity -Components of Barriers to Open Innovation Practices

To provide validity for the construct of barriers to OI practices in the surveyed companies from TDZs of Turkey, a factor analysis is conducted. Exploratory factor analysis has been performed to determine construct validity of the scales regarding constraints/barriers to OI. All items in four groups that are related to general constraints on OI (Table 3: Open Innovation Constraints in SMEs from Rahman & Ramos (2013); Table 4: Barriers to using OI in the organization for SMEs from Krause et al. (2012)), constraints on inbound and outbound open innovation (Table 5: Barriers to inbound and outbound open innovation from Savitskaya et al. (2010), and human resources constraints on OI (Table 3: Open Innovation Constraints in SMEs from Rahman & Ramos (2013)) have been subjected to factor analysis.

Before performing Principal Component Analysis, appropriateness of constraints to open innovation to exploratory factor analysis is evaluated. Table 13 shows the results of KMO and Bartlett's Test. KMO value of the scale is 0.857. In this case, this value is meritorious and enough to continue with factor analysis. Additionally, value of Barlett's Test of Sphericity is meaningful as null hypothesis (All correlation coefficients are not quite far from zero) is rejected on a level of statistical significance $p<0.001$. When both results are taken into account, exploratory factor analysis can be performed.

Table 13. Results of KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		,857
Bartlett's Test of Sphericity	Approx. Chi-Square	1123,858
	Df	253
	Sig.	,000

According to Tabachnick & Fidell (2001), factor loading of each item should be higher than 0.32 as a basic guide. In addition, according to Buyukozturk (2002) factor loading between 0.30 and 0.59 is considered as moderately high since values higher than 0.60 is considered as high. Furthermore, difference between two factor loadings should be more than 0.10 if factor loading of an item has high values in two factors (Tabachnick & Fidell, 2001). Finally, communalities for each item have a value over 0.5 that indicates satisfactory quality of the measurements. By considering all these criteria, factors have been determined. Because the factor loadings of "intellectual property rights", "user acceptance", "lack of marketplaces for technologies", "knowledge" and "too much time and resources" are high in more than one factor and difference between them are less than 0.10, these three items have been removed from factor analysis.

Using Kaiser's criterion (i.e. eigenvalue>1), principal component analysis extracted six factors that explain 68.053% of the total variance of constraints to open innovation (Table 14).

Table 14. Total Variance Explained

Factors	Eigenvalue	Variances, %	Cumulative, %
F1	8,184	35,583	35,583
F2	1,900	8,262	43,845
F3	1,564	6,799	50,644
F4	1,479	6,431	57,074
F5	1,388	6,033	63,108
F6	1,137	4,946	68,053

F7 (not included)	,846	3,677	71,731

In order to provide easier interpretation of results, varimax rotation is used. After the exploratory factor analysis, the identified factors that are named in accordance with their content and components from questionnaire (items) are listed in Table 15.

More specifically, based on constraints on OI as presented by the factor analysis, items "not sold here syndrome", "complexity of the intellectual property rights, fear of infringements", "fear of losing own innovation ability", "not invented here syndrome", "the difficulty of finding buyers", and "employees are reluctant to share information" particularly with high loadings (0.766, 0.739, 0.696, 0.664, 0.618, 0.551) load on the first factor F1, with eigenvalue 8.184, which explains 35.583% of total dispersion. Factor 1, which we titled as Fear and Conservativeness, represents "fear and conservativeness" is the most important dimension in explaining total variance (35.58%) of total variance.

5 items that are related to constraints on inbound and outbound open innovations that were taken from the study of Savitskaya et al. (2010) are clustered Factor 1. Additionally, remained one item "employees are reluctant to share information" was added by the expert from ITU Technology Transfer Office.

Items "unpleasant works", "unpleasant working conditions", "lack of skilled manpower", "high staff turnover", and "low image of the firm" particularly with high loadings (0.821, 0.764, 0.727, 0.628, 0.568) load on the second factor F2, with eigenvalue 1.9, which explains 8.262% of total dispersion. Factor 2 consists of the constraints human resources and image. Depending on the views of the expert that were taken to provide the face validity of the survey, "low image of the sector" and "low image of the type of enterprise" items that were taken from the study of Rahman & Ramos (2013) were removed. Instead, "low image of the firm" has been added to questionnaire. Remaining four statements of Factor 2 are taken from the study of Rahman & Ramos (2013).

Items "marketing", "high wage levels", "resources", and "competent employees" particularly with high loadings (0.734, 0.670, 0.622, 0.586) load on F3, with eigenvalue 1.564, which explains 6.799% of total dispersion. Factor 3 includes items regarding resources and costs. Marketing item is related to "marketing competency, capability and resources" and the question that refers to "insufficient market intelligence, market affinity, marketing problems with new products" was taken from the study of Krause et al. (2012). Statement "high wage levels" is adopted from the study of Rahman & Ramos (2013) and other three statements are adapted from the study of Krause et al. (2012).

Items "commitment", "organization/culture", and "idea management" particularly with high loadings (0.737, 0.711, 0.595) load on the fourth factor, with eigenvalue 1.479, which explains 6.431% of total dispersion. Factor 4 includes items regarding Management and Organization and were taken from the "general constraints on OI" list of Rahman & Ramos (2013).

Table 15. Components and Factor Loadings

FACTORS	Factor Loading	Communality
F1: Fears, Conservativeness		
Not sold here syndrome	0,766	0,742
The complexity of the intellectual property rights, fear of infringements	0,739	0,663
Fear of losing own innovation ability	0,696	0,660
Not invented here syndrome	0,664	0,713
The difficulty of finding buyers	0,618	0,759
Employees are reluctant to share information	0,551	0,686
F2: Human Resources Constraints and Image Problems		
Unpleasant works	0,821	0,745
Unpleasant working conditions	0,764	0,695
Lack of skilled manpower	0,727	0,692
The high staff turnover	0,628	0,660
The low image of the firm	0,568	0,635

F3: Resource Constraints and Cost Challenges		
Marketing	0,734	0,706
High wage levels	0,670	0,603
Resources	0,622	0,681
Competent employees	0,586	0,681
F4: Management and Organization		
Commitment	0,737	0,656
Organization/Culture	0,711	0,635
Idea Management	0,595	0,576
F5: Value Chain Challenges		
Customer demand	0,760	0,716
Partners	0,711	0,623
No adequate technologies on offer	0,684	0,637
F6: Financial and Administrative Challenges		
Administration	0,792	0,701
Finance	0,765	0,785
Extraction Method: *Principal Component Analysis.* ***Rotation Method:*** *Varimax with Kaiser Normalization.*		

Items "customer demand", "partners", and "no adequate technologies on offer" particularly with high loadings (0.760, 0.711, and 0.684) load on the fifth factor, with eigenvalue 1.388, which explains 6.033% of total dispersion. Factor 5 was denominated value chain related (marketing, demand, partners, technology supply) constraints. Statement "no adequate technologies on offer" is adapted from the "constraints on inbound open innovation" of Savitskaya et al. (2010) and other statements are taken from the study of Krause et al. (2012).

The sixth and last factor F6 has eigenvalue of 1.137 and high loadings (0.792, 0.765) which explains 4.946% of total dispersion, was constructed by items regarding financial/administrative constraints.

The descriptive statistics regarding the factors are shown in Table 16 in which the factors' mean varies between 2.84 and 3.47. Here, 5-point Likert scale ranges from "never" to "a great deal". The responses indicate that all barriers are perceived to have a moderate value and findings do not underline a significantly strong barrier. F2 and F4 are the constraints with the lowest value (and related to non-pecuniary factors), while the most frequently faced constraints (F3 and F6) require conflicting rules, administrative burdens or financial resources.

Most of the constructs are multidimensional and subjective. Hence, Cronbach's alpha internal consistency coefficients were used to test the reliability/ internal consistency of the factors (Cronbach, 1947). As shown in Table 16, all coefficients are beyond 0.7 which is the minimum acceptable reliability level (Nunnaly, 1978), ensuring that the factors are sufficiently reliable.

Table 16. Descriptive Statistics Regarding Factors

Factors	N	Mean	Std. Dev	Nr of Components	Cronbach's Alpha
F1: Concerns about confidentiality and conservativeness	102	2,951	,917	6	0,872
F2: Human Resources Constraints and Image problems	102	2,835	,949	5	0,838
F3: Resource Constraints and Cost Challenges	102	3,414	,957	4	0,777
F4: Management and Organization	102	2,928	,855	3	0,747
F5: Value Chain Challenges	102	2,987	,877	3	0,704
F6: Financial and Administrative Challenges	102	3,471	1,128	2	0,700

3.4 Relationships between Company Characteristics and Factors of Open Innovation Barriers

For understanding the contingency dimension, relationships between company characteristics and factors of open innovation barriers (found in the previous section) are explored by difference tests.

Barriers and Age of the company (H1): First test was applied for all factors for differing by the "Age of the company". As mentioned before, H1 hypothesis is constructed on whether there is a statistically significant difference in frequencies of encountering constraints (Factor 1, 2, 3, 4, 5, 6) in OI practices with respect to age of the company.

To test hypothesis, independent samples t-Test has been performed because the variables are normally distributed and there are two groups of foundation year (before 2010, after 2010(including 2010)). All sub-hypotheses are rejected and there is no significant difference by age is found in terms of encountered constraints/barriers on implementing OI. Table 17 shows test statistics of t-Test for all factors regarding constraints on OI and age of the company.

Table 17. T-Test Results for Constraints on Open Innovation and Age of The Company

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval	
									Lower	Upper
F1. Confidentiality conservativeness	Equal variances assumed	1,093	,298	1,128	100	,262	,20462	,18137	-,15523	,56446
	Equal variances not assumed			1,126	98,278	,263	,20462	,18171	-,15597	,56520
F2. Human resources, brand and image	Equal variances assumed	,400	,528	,700	100	,485	,13200	,18848	-,24193	,50593
	Equal variances not assumed			,700	99,770	,485	,13200	,18851	-,24200	,50600
F3. Resources & costs	Equal variances assumed	1,441	,233	,922	100	,359	,17500	,18975	-,20147	,55147
	Equal variances not assumed			,919	95,514	,360	,17500	,19042	-,20301	,55301
F4. Management and organization	Equal variances assumed	1,115	,294	1,255	100	,212	,21205	,16896	-,12317	,54727
	Equal variances not assumed			1,249	92,724	,215	,21205	,16977	-,12510	,54920
F5. Value Chain challenges	Equal variances assumed	1,753	,189	,603	100	,548	,10513	,17434	-,24076	,45102
	Equal variances not assumed			,601	95,497	,549	,10513	,17496	-,24219	,45244
F6. Financial &Administrative Challenges	Equal variances assumed	,249	,619	,530	100	,597	,11885	,22413	-,32583	,56352
	Equal variances not assumed			,530	99,679	,597	,11885	,22421	-,32600	,56369

Barriers and Type of the firm (H2): Second hypothesis set is constructed on the relationships between type of the firm (independent or subsidiary of an international company) and the factors of barriers in practicing OI. Due to the fact that variables are normally distributed and there are two groups of firm type (a subsidiary of an international company, an independent company), t-Test has been performed. All sub-hypotheses are rejected for Factor 1, 2, 3, 4, 5, and 6 ($p>0.05$).

Table 18. T-Test Results for Constraints on Open Innovation and Type of The Firm

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval	
									Lower	Upper
F1. Confidentiality conservativeness	Equal variance assumed	,464	,497	-,350	100	,727	-,12632	,36069	-,84191	,58928
	Equal variances not assumed			-,404	7,288	,698	-,12632	,31258	-,85957	,60694

F2. Human resources, brand and image	Equal variances assumed	,009	,924	-1,514	100	,133	-,55940	,36938	-1,29223	,17343
	Equal variances not assumed			-1,605	7,049	,152	-,55940	,34863	-1,38261	,26382
F3. Resources & costs	Equal variances assumed	,073	,788	-,571	100	,570	-,21466	,37618	-,96100	,53168
	Equal variances not assumed			-,570	6,911	,587	-,21466	,37675	-1,10785	,67853
F4. Management and organization	Equal variances assumed	,005	,946	,381	100	,704	,12832	,33647	-,53923	,79587
	Equal variances not assumed			,406	7,059	,697	,12832	,31630	-,61834	,87498
F5. Value Chain challenges	Equal variances assumed	,014	,906	1,539	100	,127	,52531	,34134	-,15189	1,20252
	Equal variances not assumed			1,494	6,853	,180	,52531	,35158	-,30968	1,36031
F6. Financial &Administrative Challenges	Equal variances assumed	2,158	,145	-1,861	100	,066	-,81203	,43631	-1,67766	,05360
	Equal variances not assumed			-1,462	6,517	,190	-,81203	,55536	-2,14523	,52117

Barriers and Number of Employees (Scale) (H3): Third hypotheses set referred to the relationships between the number of employees (scale) and constraints on OI. To test hypotheses, ANOVA Test was performed as variables are normally distributed and there are more than two groups of employee number (1-9, 10-49, 50-99, 100-250, and more than 250). Table 19 shows statistics of ANOVA for all hypotheses regarding constraints on open innovation and number of employees and turnover. ANOVA shows that there is not a statistically significant difference in frequencies of encountering constraints on OI with respect to the number since all p-values are greater than 0.05 (0.576, 0.296, 0.884, 0.564, 0.188, and 0.830 respectively).

Table 19. ANOVA Test Results for Constraints on Open Innovation and Number of Employees

		Sum of Squares	df	Mean Square	F	Sig.
F1. Confidentiality conservativeness	Between Groups	2,472	4	,618	,727	,576
	Within Groups	82,450	97	,850		
	Total	84,922	101			
F2. Human resources, brand and image	Between Groups	4,453	4	1,113	1,248	,296
	Within Groups	86,540	97	,892		
	Total	90,993	101			
F3. Resources & costs	Between Groups	1,093	4	,273	,290	,884
	Within Groups	91,469	97	,943		
	Total	92,562	101			
F4. Management and organization	Between Groups	2,201	4	,550	,744	,564
	Within Groups	71,716	97	,739		
	Total	73,917	101			
F5. Value Chain challenges	Between Groups	4,728	4	1,182	1,570	,188
	Within Groups	73,032	97	,753		
	Total	77,760	101			
F6. Financial &Administrative Challenges	Between Groups	1,925	4	,481	,369	,830
	Within Groups	126,487	97	1,304		
	Total	128,412	101			

Barriers and Turnover (Scale) (H4): The relationship between the barriers and annual turnover of the company was also explored and tested. ANOVA Test is performed as the variables are normally distributed and there are more than two groups of annual turnover (less than 1 million TL, 1 million TL-8 million TL, 8 million TL-25 million TL, 25 million TL-40 million TL, more than 40 million TL). One way ANOVA results show that all hypotheses have been rejected due to the fact that p-values of these hypotheses are greater than 0.05 (0.675, 0.761, 0.672, 0.706, 0.899, and 0.129 respectively). Hence, there is not a statistically significant difference in frequencies of encountering constraints on OI with respect to annual turnover of the company.

Table 20. ANOVA Test Results for Constraints on Open Innovation and Turnover

		Sum of Squares	df	Mean Square	F	Sig.
F1. Confidentiality conservativeness	Between Groups	1,996	4	,499	,584	,675
	Within Groups	82,925	97	,855		
	Total	84,922	101			
F2. Human resources, brand and image	Between Groups	1,711	4	,428	,465	,761
	Within Groups	89,282	97	,920		
	Total	90,993	101			
F3. Resources & costs	Between Groups	2,190	4	,548	,588	,672
	Within Groups	90,371	97	,932		
	Total	92,562	101			
F4. Management and organization	Between Groups	1,613	4	,403	,541	,706
	Within Groups	72,304	97	,745		
	Total	73,917	101			
F5. Value Chain challenges	Between Groups	,843	4	,211	,266	,899
	Within Groups	76,917	97	,793		
	Total	77,760	101			
F6. Financial &Administrative Challenges	Between Groups	9,019	4	2,255	1,832	,129
	Within Groups	119,393	97	1,231		
	Total	128,412	101			

Barriers and Duration of Practicing Open Innovation (Experience) (H_5): Owing to the fact that variables are normally distributed and there are more than two groups of duration of practicing OI (less than 1 year, 1-3 years, more than 3 years), ANOVA is used to test the hypotheses. Table 21 shows statistics of ANOVA for all hypotheses regarding duration of practicing OI and frequencies of encounter constraints on OI. All hypotheses have been rejected because p-values are greater than 0.05 (0.362, 0.389, 0.633, 0.541, 0.468, and 0.069 respectively). Therefore, there is not a statistically significant difference in frequencies of encountering any constraints on OI with respect to duration of practicing OI. It can be said that duration of practice does not affect frequency of constraints regarding OI.

Table 21. ANOVA Test Results for Constraints on Open Innovation and Duration of Practicing Open Innovation

		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
F1. Confidentiality conservativeness	Between Groups	1,724	2	,862	1,025	,362
	Within Groups	83,198	99	,840		
	Total	84,922	101			
F2. Human resources, brand and image	Between Groups	1,720	2	,860	,954	,389
	Within Groups	89,273	99	,902		
	Total	90,993	101			
F3. Resources & costs	Between Groups	,852	2	,426	,460	,633
	Within Groups	91,710	99	,926		
	Total	92,562	101			
F4. Management and organization	Between Groups	,911	2	,455	,618	,541
	Within Groups	73,006	99	,737		
	Total	73,917	101			
F5. Value Chain challenges	Between Groups	1,185	2	,592	,766	,468
	Within Groups	76,575	99	,773		
	Total	77,760	101			
F6. Financial &Administrative Challenges	Between Groups	6,759	2	3,379	2,750	,069
	Within Groups	121,653	99	1,229		
	Total	128,412	101			

4. Discussion

Most of the explored companies introduced product and service innovations in-house; they have also practiced some OI methods like customer immersion and lead users, collaboration and partly innovation intermediaries, innovation networks and platforming. However, some of the companies strictly reject the OI practices of "idea competitions and challenges", "IP in-licensing or acquisition",

and "IP tech-out licensing". Generally, it can be said that ICT companies that operate in TDZs in Turkey are in a transitional position from closed innovation approach to OI approach. Also, the same trend continues with management support.

After applying factor analysis, fears, conservativeness, human resource constraints and image problems, management and organization, resource constraints and cost challenges, value chain constraints and financial/administrative are identified as constraints that act as barriers to practicing OI effectively in the surveyed ICT firms. In alignment with the authors' previous research (Yildirim & Simsek, 2015; Simsek & Yildirim, 2016) on open innovation constraints also non-pecuniary open innovation activities are more popular among them. Hence, the most frequently perceived constraints act as the main reason of why these firms mostly focus on open innovation practices which do not require conflicting rules, administrative burdens or financial resources. According to Gruber & Henkel (2006), small companies face challenges such as unknown organizational entity, lack of trust in the abilities and offering, reliance on social interaction among strangers, lack of exchange relationship due to their newness. Small firms cannot resist unfavorable business conditions and they can suffer from even minor inefficiencies owing to lack of financial resources (Gruber & Henkel, 2006). In addition, Narula (2004) argues that SMEs are constrained by their limited resources because of their smallness. On the other side, most of the participating companies were founded after 2010 and they are in disadvantageous position compared to mature firms. It can be argued that the most frequent constraints encountered by technology-intensive companies, which are mostly small and medium-sized enterprises in this study, regarding open innovation are caused by smallness and newness of them. Additionally, van de Vrande et al. (2009) suggest that the most important constraints to open innovation result from causes like cultural and organizational problems and these problems arise often when small and medium-sized enterprises interact with external partners. In analogy to the findings of the relevant literature (Gassmann et al., 2010; Krause et al., 2012; Rahman & Ramos, 2013), resource constraints and cost challenges are also perceived as significantly important for the companies in TDZs in Turkey. Constraints regarding human resource, brand and image are the least frequently encountered constraints by technology-intensive companies that operate in TDZs in Turkey. Findings of this paper regarding constraints on open innovation are in line with findings of mentioned studies.

On the other hand, none of the barriers were rated as highly significant by the respondents. Hence, in order to elaborate these barriers, field research including ethnographic and observational techniques are needed to be applied for data re-collection. Barriers to OI do not differ by annual turnover level, establishment date or age of the company, number of employees or the duration of open innovation practice.

Conclusion

Providing insights about the open innovation practices and barriers for adopting OI in ICT companies in TDZs, findings reveal that the companies still have a long way to go on adopting open innovation effectively to achieve high competitiveness. However, there is a slight trend toward practicing OI and this can be accelerated by removing the barriers on OI in TDZ context. Companies in TDZs mostly benefit from the knowledge of their employees including non R&D workers and involve customers in innovation process to conduct an active market research to understand their needs.

This study draws attention to the perceptions of companies in TDZs about the constraints and barriers to open innovation. This stands as the first step towards designing strategies and taking actions to overcome these constraints and hence to enable these companies to utilize open innovation methods for competing with their strong competitors.

Findings of the study regarding the barriers faced in the current practices of ICT firms in the TDZs can be utilized while designing appropriate strategies and incentives to foster OI in TDZs. The list of factors which presents constraints on open innovation practices, can be utilized as a scale in further research by practitioners. Moreover, as study revealed a consistency between literature and findings, theoretical frame of open innovation constraints can also be valid for ICT companies that

are operating in TDZs in Turkey. Another contribution of the study is building linkages between organizational theories and the problems that are faced in open innovation practices.

Future research should broaden the scope of research to explore barriers to open innovation in more extensive and broader sample and including companies from other sectors. Causality, directional relationships between factors is in our research agenda. The study is expected to be enhanced by the data on the motivations of the respondent companies for OI and the identified causalities between the motives and barriers can provide insights about the impact of culture, strategy and structure on the perceptions of ICT companies in TDZs about open innovation. Sample of the study is limited to ICT companies that operate in TDZs in Turkey and are mostly micro, small and medium-sized enterprises. Also, actions to compensate barriers to open innovation are suggested to research.

This research does not reveal differences between small and large companies in terms of constraints to open innovation and this gap should be filled by further research. Factors are formed with the most common difficulties in open innovation. Obstacles to open innovation in future research should be subjected to in depth analysis of exceptions.

References

Allen, T.J. & Cohen, S.I., (1969), Information Flow in Research and Development Laboratories. Administrative Science Quarterly, 14(1), 12–19.

Ashrafi, R. & Murtaza, M. (2008). Use and impact of ICT on SMEs in Oman. The Electronic Journal Information Systems Evaluation, 11(3), 125-138.

Brunswicker, S. & Ehrenmann, F. (2013). Managing Open Innovation in SMEs: A Good Practice Example of a German Software Firm. International Journal of Industrial Engineering and Management, 4(1), 33 – 41.

Buyukozturk, S. (2002). Faktör Analizi: Temel Kavramlar ve Ölçek Geliştirmede Kullanımı. *Kuram ve Uygulamada Eğitim Yönetimi*, 32, 470-483.

Carter, C.F. & Williams, B.R., (1959), The Characteristics of Technically Progressive Firms. Journal of Industrial Economics, 7(2), 87–104.

Chandler, A.D., Jr. (1990). Scale and Scope: The Dynamics of Industrial Capitalism, Cambridge, MA: Harvard University Press.

Chesbrough, H.W., (2003a), Open Innovation: The new imperative for creating and profiting from technology. Boston, Mass.: Harvard Business School Press.

Chesbrough, H.W., Vanhaverbeke, W. & West, J.,(eds.) (2006),Open Innovation: Researching a New Paradigm, Oxford University Press.

Chesbrough, H.W. & Crowther, A.K., (2006), Beyond High Tech: Early adopters of open innovation in other industries. R&D Management, 36(3), 229–236.

Chesbrough, H.W., (2010), Open Innovation: A Key to Achieving Socioeconomic Evolution How Smaller Companies can benefit from Open Innovation. Economy, Culture & History Japan Spotlight Bimonthly, JAPECO, Japan Economic Foundation.

Chesbrough, H, W. & Brunswicker, S. (2013). Managing Open Innovation in Large Firms, Survey Report, Fraunhofer Society.

CIS Survey, (2010). European Commission Web Site, http://ec.europa.eu/eurostat/web/microdata/community-innovation-survey - retrieved in Dec. 2015.

Colombo, M.G & Delmastro, M., (2002), How Effective are Technology Business Incubators: Evidence from Italy. Research Policy, 31, 1103-1122.

Cohen, W.M. & Levinthal, D.A., (1990), Absorptive capacity: A new perspective on learning and innovation. Administrative Science Quarterly, 35(1), 128–152.

Cronbach, L. J., (1947). Test reliability: Its meaning and determination. Psychometrika, 12.1, 1-16.

Gassmann, O., Enkel, E. & Chesbrough, H.W., (2010), The Future of Open Innovation. R&D Management, 40(3), 213-221.

Grant, R., (1991), The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation. California Management Review, 33(3), 114- 135.

Gruber, M. & Henkel, J., (2006), New ventures based on open innovation – An empirical analysis of start–up firms in embedded Linux. International Journal of Technology Management, 33, 356-357.

Hamdani, J. & Wirawan, C. (2012). Open Innovation Implementation to Sustain Indonesian SMEs. Procedia Economics and Finance, 4,223 – 233.

Herzog, P. & Leker, J., (2010), Open and Closed Innovation: Different Innovation Cultures for Different Strategies. International Journal of Technology Management, 52(3-4), 322-343.

Hutter, K., Hautz, J., Repke, K. & Matzler, K. (2013). Open Innovation in Small and Micro Enterprises. Problems and Perspectives in Management, 11(1), 12-22.

Kaufmann, A. & Tödtling, F. (2002). How effective is innovation support for SMEs? An analysis of the region of Upper Austria. Technovation, 22 (3), 147-159.

Katz, R. & Allen, T.J., (1982), Investigating the not-invented-here (NIH) syndrome: a look at performance, tenure and communication patterns of 50 R&D project groups. R&D Management, 12(1), 7–20.

Krause, W., Schutte, C. & du Preez, N., (2012), Open Innovation in South African Small and Medium-Sized Enterprises, Proceedings of the International Conference on Computers & Industrial Engineering (CIE42), Cape Town, South Africa, CIE & SAIIE 2012: 201-210.

Laforet, S. (2008). Size, strategic, and market orientation effects on innovation. Journal of Business Research, 61(7), 753–764.

Lichtenthaler, U., (2008), Open innovation in practice: an analysis of strategic approaches to technology transactions. IEEE Transactions on Engineering Management, 55(1), 148–157.

Narasimhalu, A.D. (2013). CUGAR: A model for open innovation in Science and Technology Parks, Research Collection School of Information Systems, 2(1), 10-20.

Narula, R., (2004), R&D collaboration by SMEs: New opportunities and limitations in the face of globalization. Technovation, 24(2), 153–161.

Nunnaly, J. (1978). Psychometric theory (2nd edition). New York: McGraw-Hill.

OECD/Eurostat (2005) Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, 3rd Edition, The Measurement of Scientific and Technological Activities, OECD Publishing, Paris.

Parida, V., Westerberg, M. & Frishammar, J. (2012). Inbound Open Innovation Activities in High-Tech SMEs: The Impact on Innovation Performance. Journal of Small Business Management, 50(2), 283-309.

Rahman, H. & Ramos, I., (2013), Challenges in Adopting Strategies in SMEs: An Exploratory Study in Portugal. Issues in Informing Science and Information Technology, 10, 431-448.

Research and Investigation Report, (2009). 4691 sayılı Teknoloji Geliştirme Bölgeleri Kanunu Uygulamalarının Değerlendirilmesi ile Uygulamada Ortaya Çıkan Sorunların Çözümüne İlişkin Öneri Geliştirilmesi, 2009, 1, pp. 33 https://www.tccb.gov.tr/ddk/ddk26.pdf

SAGM (2014). Turkish Republic Ministry of Industry and Technology, Technology Development Zones Report 2014.http://sagm.sanayi.gov.tr/userfiles/file/TGB%20g%C3%BCncel%20d%C3%B6k%C3%BCmanlar/TGB%20GENEL%2017_10_2014.pdf

Savitskaya, I., Salmi, P. & Torkkeli, M., (2010), Barriers to Open Innovation: Case China. Journal of Technology Management & Innovation, 5(4), 10-21.

Scozzi, B., Garavelli, C. & Crowston, K. (2005). Methods for modeling and supporting innovation processes in SMEs. European Journal of Innovation Management, 8(1), 120-137.

Simonin, B.L., (1999), Ambiguity and the process of knowledge transfer in strategic alliances. Strategic Management Journal, 20(7), 595-623.

Simsek, K. & Yildirim, N. (2016). "Constraints to Open Innovation in Science and Technology Parks", 12th International Strategic Management Conference, ISMC 2016, 28-30 October 2016, Antalya, Turkey, 939-950.

Spithoven, A., Clarysse, B. & Knockaert, M., (2010), Building absorptive capacity to organize inbound open innovation in traditional industries. Technovation, 30(2), 130–141

Tabachnick, B. & Fidell, L. (2001). Using multivariate statistics. Needham Heights: Allyn & Bacon.

TGBD, (2015). Teknoloji Geliştirme Bölgeleri Derneği – Technology Development Zones Association in Turkey, Databank. http://www.tgbd.org.tr/tr/turkiye-de-teknoparklar-18.html>, date retrieved 07.03.2015.

Trott, P. & Hartmann, D., (2009), Why Open Innovation is Old Wine in New Bottles. International Journal of Innovation Management, 13(4), 715-736.

Van de Vrande, V., deJong, J.P.J., Vanhaverbeke, W. & de Rochemont, M., (2009), Open innovation in SMEs: Trends, motives and management challenges. Technovation, 29(6-7), 423–437.

WIPO (2014). Date retrieved 12.12.2014, address: http://www.wipo.int/wipolex/en/text.jsp?file_id=245146

Yalcintas, M. (2014). Üniversite – Sanayi – Devlet İşbirliğinin Ülke Ekonomilerine Etkileri: Teknopark İstanbul Örneği, Finansal Araştırmalar ve Çalışmalar Dergisi, 5(10), 83-106.

Yildirim, N. & Simsek, K., (2015). Challenges in Open Innovation for ICT Companies in University Technology Development Zones, 24th International Conference on Management of Technology – IAMOT, June 8-11, 2015 Cape Town, South Africa.