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Application of Technology Alliance Model (TAM) on R&D Firms of Some Technology Development Zones (TDZS) in Ankara

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Abstract

The study aims to apply the Technology Alliance Model (TAM) (Ju et. al., 2005, p. 623) on R&D firms in some TDZs in Ankara. In order to do so, a literature review is conducted and the theory of the research is developed according to the findings of the review. Moreover, some hypotheses are derived. In order to test these hypotheses, a survey is adopted from prior studies and applied to randomly selected sample of 207 from different TDZs in Ankara. The data is analyzed in terms of descriptive statistics, reliability analysis, ANOVA, correlations, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA).

The results revealed that TAM is valid in some TDZs in Ankara. The study covers the theory of the model and tests it empirically. It is hoped that the academics and practitioners can make use of the research methodology and findings. Lastly, some research implications for future research are mentioned.

Keywords – Technology Alliance Model, R&D firms, Technoparks
Gel Code: M11

1. Introduction

In today's global economy, the potential development is being carried by the intensity of R&D firms and the investment being done on these firms (Lidija & Probert, 2014, p. 368). So, these firms are being supported in many ways in TDZs. They can make use of specialized areas for R&D processes, make use of research infrastructure and human resources of universities and have an access to finance by means of angel investors and governmental funds. Nevertheless, when compared to the developed countries, the investment being done in R&D is limited and the number of people employed in R&D facilities are penurious. So, these firms should be supported by scientific research on their ongoing processes. Moreover, there are research calls in this respect. For instance, Lidija & Probert (2014, p. 368) draws attention to the conceptual chaos on defining innovation capabilities and this also shows the need for more research aiming to understand the effects of innovation and technology issues on enterprises.

Moving here, the present study aims to apply TAM in R&D firms in some TDZs in Ankara. With this aim, the study includes a detailed literature review on components of the model. The review uncovered many useful information on the theory and methodology of the research. Afterwards, a survey is adopted from prior studies and applied to a randomly defined sample of 207. The analysis of the data initially included the demography and descriptive statistics of the sample. The results verified that the sample represents the context. Later on, the reliability of the data is assessed via Cronbach alphas. The inter-item correlations are calculated. ANOVA tests are conducted in order to see whether the demography of the sample affect the responses of the sample. EFA and CFA are executed and the results verified the theory of the research. Lastly, some hypotheses derived from TAM are tested and helpful findings for academics and practitioners are obtained.

2. Literature Review

The need for better technology management applications in enterprises increase, according to the newly developed technologies and rapidly changing customer choices (Liu & Jiang, 2016, p. 889). The ability to compete is bound to the ability to manage technology (Gilmore & Carson, 1996, p. 51). The literature is rich in studies on the sub-dimensions of Technology Alliance Model (TAM). However, there is only one study covering TAM as one of the major concepts in the study (Ju et. al., 2005, p. 623). The sub-dimensions of the model are valuable as it explains innovation and technology management in theory.

Hertog et. al. (2010, p. 490) tried to construct a framework on innovation capabilities. The results of the study empirically proved signaling user needs and technological options; conceptualizing; bundling; co-producing and orchestrating; scaling and stretching; and learning and adapting as innovative capabilities.

Meanwhile, Lingren et. al. (2009, p. 17) summarized innovative capabilities by focusing on intellectual ones. The study proposes that if the firms are aware of the innovative capabilities their operation flexibility rises. Parallel to these Tepic et. al. (2014, p. 228) preferred food and beverages sector and investigated the innovation capabilities. The paper proposes that the formerly mentioned innovation capabilities can be adapted according to the specific needs of the studies.

Moreover, Barbaroux (2012, p. 232) identified collaborative innovation capabilities and according to the study the innovative environment pushes people to leverage complementarities between internal and external sources of innovation; to codify, capitalize and disseminate knowledge outcomes; and to align product and organizations in a dynamic.

Besides, Daspit & Zavattaro (2014, p. 206) focused on integrating innovation and absorptive capacity into the place branding processes. The study covers some innovative capabilities and a useful definition of innovation capability.

Lidija & Probert (2014, p. 368) investigated the relationship between dynamic capabilities and innovation capability. The study asserts that there are different perspectives on this relationship. The first point of view handles innovation capability as one of the dynamic capabilities. There are also studies covering dynamic capability as an outcome of innovation capabilities. Similar to the first point of view there are studies accepting innovation capability as a component of dynamic capability. Besides these there are studies approaching dynamic capability as a precondition for innovation capability. On the other hand there are also studies asserting innovation capability is not a dynamic capability. Lastly there are also studies mentioning innovation capability as a synonym for dynamic capability. To this end, this situation shows that there is need for more research on this topic. Cheng & Chen (2013, p.

444) also focused on dynamic innovation capabilities. They conclude that the dynamic innovation capabilities boost innovation throughout the enterprise.

Similarly, Fernandez-Mesa et. al. (2013, p. 547) focused on design management capability and product innovation in SMEs. The authors assert that there are relationships between organizational learning, design management capability and product innovation. Especially in product innovation, Herrmann et. al. (2006, p. 20) defined determiners of radical product innovation. Developing new products, clustering suppliers and customers, investing on innovation, being able to create new customers, strategic approaching to the market, market-oriented organization and lifelong learning are depicted as determiners of product innovation.

Liu & Jiang (2016, p. 883) investigated the influence of technological innovation capabilities on product competitiveness. The study proved that the firm's knowledge resources, fundamental research, application R&D, and manufacturing capabilities have significant influence on the new product development performance and product competitiveness.

To sum all up, there are many studies covering the components of TAM in many different contexts, but there is scarcity of research on directly handling the model itself. The present study made use of the findings, theory and methodology of the prior studies in many ways.

3. Technology Alliance Model

The model is uttered by Ju et. al. (2005, p. 623) and covers the innovation and technology management issues at the same time. They included technology management capabilities, process and product innovation capabilities, quality management and technology competence. The present study deploys their classification and develops the theory and hypotheses as follows.

3.1. Technology management capabilities

These capabilities play a crucial role on the performance of the enterprise. These are mentioned as defining, selecting, acquiring, using, protecting and ending (Tekin & Göral, 2010, p. 293). The need for technology should be defined well. Also, the managers of the enterprises should decide on the energy consumption, employee need, congruity with the current infrastructure and financial issues (Marcus, 2016, p. 117). Moreover, decisions should be taken using the new technology. Lastly, the intellectual property rights should be protected and the right time to end using the acquired technology is also be defined. Moving here, the following hypotheses are derived;

H1: The technology management capabilities should be in accordance with process innovation capabilities.

H2: The technology management capabilities should affect product innovation capabilities.

H3: The technology management capabilities affect quality management competence positively.

H4: The technology management capabilities affect technology competence in a positive way.

3.2. Process innovation capabilities

The process innovation capability is defined as the organization's meaningful and systematic use of internal knowledge and resources to deliver new or improved processes, practices, and/or services (Daspit & Zavattaro, 2014, p. 215). So, there is need for change in processes of the firm in order to allow technology alliance. Hertog et. al. (2010, p. 490)'s classification on process innovation capabilities is used in the theory of the present study. Their proposition

included signaling, conceptualizing, building, producing, scaling and learning. Furthermore, Lingren et. al. (2009, p. 17) proposed that if the firms are aware of the innovative capabilities their operation flexibility rises. So the following hypotheses are generated;
H5: Process innovation capabilities affect product innovation capabilities positively.
H6: Process innovation capabilities affect quality management capabilities in a positive way.
H7: Process innovation capabilities and technology competence are positively associated.

3.3. Product innovation capabilities

Enterprises need product innovation as the demand change according to the global changes (Hertog et.al., 2010, p. 500). Alonso-Rasgado (2004, p. 515) defines product innovation in three main dimensions. These are namely understanding clients' needs, transferring intellectual property and simultaneous development of client needs and concepts. Moreover, Fernandez-Mesa et. al. (2013, p. 547) proposed relationships between organizational learning and product innovation. Similarly, Liu & Jiang (2016, p. 883) asserts that the new product development performance of the firm is bound to its innovativeness. Then the following hypotheses are formed;
H8: Product innovation capabilities are positively associated with quality management capabilities.
H9: Product innovation capabilities and technology competence are positively associated.

3.4. Quality management competence

Quality management competence has a long history (Weckenmann et al., 2015, p. 281) and it is another issue that the R&D firms face in their processes (Ju et al., 2005, p. 623). The sustainability and development of quality ensures customer satisfaction and lastly loyalty (Palmberge & Garvare, 2006, p. 42). The present study deploys Power (2014, p. 1184)'s proposition for quality management competence in terms of certification, customer returns, work in process and final inspection as his study covers high-tech firms. Bergenhenegouwen et al. (1996, p. 29) suggested that firms can build their performance and competence by paying attention to the quality issues. So, the following hypothesis is derived;
H10: Quality management competence affects technology competence in a positive way.

3.5. Technology competence

The ability to use technology effectively has an effect on the technology management, process and product innovation and quality management of the firms (Yu et al., 2005, p. 632). The present study deploys information, project and communication management and the state of the physical systems (suitability of the current infrastructure) as the determiners of technology competence following the classification of Gordon & Tarafdar (2007, p. 271). They suggest that the ability to develop innovativeness in the firm is bound to the competency of the firm on technology. As the hypotheses developed for the former components of the model covers the issues in technology competence, no hypothesis is developed for this variable.

4. Methodology

Liu & Jiang (2016, p. 883) reports that as the technology management capabilities of the firm increase, the new product development performance increase. The TAM is proposed by Ju et. al. (2005, p. 623) and the model covers the innovation and technology management issues at the same time. Ju et. al. (2005, p. 623) used this model as one of the major components of their model. However, this model should be tested empirically in highly innovative contexts. Moving from here, the present study aims to apply the TAM to R&D firms in some TDZs in Ankara.

In order to do so, initially a detailed literature review is done. The findings of the literature review revealed useful information to be used in the present study. Initially, the theory of the study is constituted according to the findings of the former studies. The scales used are compared and a new scale is developed according to the needs of the study. As Tepic et. al. (2014, p. 228) mentioned innovation capabilities can be adapted according to the specific needs of the studies, the present study deployed the same methodology.

The adopted survey is applied to randomly defined sample of 207 via e-mails. In order to get higher response rates follow up phone calls are conducted (Gilmore & Carlson, 1996, p. 51). The analysis of the data is done by the use of SPSS 16.0 and AMOS 14.0. It included preliminary (frequency, descriptive statistics, reliability) and relational analyses (correlations, ANOVA, EFA and CFA).

Table 1. Demographic features of the sample

	f	***%***
Technopark		
Hacettepe	46	22.2
Gazi	32	15.5
Ankara	14	6.8
ODTU	115	55.6
Gender		
Male	159	76.8
Female	48	23.2
Age Group		
min. to 30	70	33.8
31 to 35	69	33.3
36 and above	68	32.9

The demography of the sample reflected some facts on Turkish Technoparks. First of all, the highest number of respondents are obtained from ODTU as it is the biggest one in the country. Males dominated the sample as the entrepreneurship of women in Turkey has much to do. The ages of the respondents varied from 24 to 56. The data is grouped into three namely minimum to 30, 31 to 35 and 36 to highest. The first group constituted the start-up firms. The third group mainly the spin-off firms of the academics.

Table 2. Reliability Statistics

	N of Items	**Cronbach's Alpha**
Technology management capabilities	6	0.901
Process innovation capabilities	6	0.906
Product innovation capabilities	3	0.887
Quality management competence	4	0.869
Technology competence	4	0.843

The reliability of the items are calculated via Cronbach alpha scores of the items aimed to measure the same construct (Fernandez-Mesa et al., 2013, p. 555; Bakan et. al., 2015, p. 159; Cheng & Chen, 2013, p. 447). All of the variables had values higher than the acceptable thresholds (Herrmann et al., 2006, p. 32).

Table 3. Descriptive Statistics

	TMCmean	**PrcInmean**	**ProInmean**	**QMCmean**	**TCptmean**
Hacettepe	4.0217	3.4384	4.1087	3.9837	3.7446
Gazi	3.9896	3.5625	3.9479	3.5234	3.8047
Ankara	4.0714	3.6548	3.8333	4.2679	4.0357
ODTU	4.0014	3.3768	3.7739	3.6609	3.6457

The descriptive statistics are calculated by using the means of each construct for each TDZ. The technology management capability, technology competence and quality management competency performance of Ankara technopark was leading whereas ODTÜ's process innovation is the highest. Hacettepe was leading product innovation capability. The results cannot be indexed as the number of firms for each TDZ are not equal.

So, in order to see how the demographic values effect the answer, ANOVA tests are executed. These tests empirically revealed many results. Men have a negative perception on defining, selection and ending processes of technology management. Besides these, they have a negative perception on process innovation capabilities, namely signaling, building, producing, scaling and learning. Moreover, they also have a negative perception on product innovation capabilities. They perceive transferring intellectual property and simultaneous development of client needs and concepts in a negative perspective. They are also reported to have a negative perception on quality management's work in process dimension.

The tests proved many information about the ages of the respondents. The group of people with the age of 36 and above are more indecisive in using technology. Whereas the youngest group is indecisive in ending technology usage. This group is also more positive in building processes. The group of people with 31 to 35 ages are more positive in producing and scaling. On the other hand, the oldest group is unwilling to learning. Lastly, the youngest group has a more negative perception on customer returns and work in process. The only statistically significant result on respondents in terms of technoparks were the negative perception of ODTU's firms' certification perception.

Table 4. Inter-Item Correlations

	TMCmean	**PrcInmean**	**ProInmean**	**QMCmean**
PrcInmean	.438**			
ProInmean	.455**	.348**		
QMCmean	.517**	.164*	.353**	

TCptmean	.547**	.307**	.397**	.436**
TMCmean= Technology management capabilities; PrcInmean= Process innovation capabilities; ProInmean= Product innovation capabilities; QMCmean = Quality management competence; TCptmean= Technology competence				

The means of items asked for measuring the same variables are calculated and the correlations are assessed (Ju et al., 2005, p. 632; Fernandez-Mesa et al., 2013, p. 554; Liu & Jiang, 2016, p. 883). The results proved that every variable is related to each other. The technology management capabilities are correlated to technology competence most. Besides these, process and product innovation management and quality management competence are correlated to technology management capabilities.

Table 5. Rotated Component Matrix

TMC1	0.397	0.685			
TMC2		0.821			
TMC3		0.671			
TMC4		0.78			
TMC5		0.737			0.391
TMC6		0.709			
PrcIn1	0.901				
PrcIn2				0.807	
PrcIn3	0.942				
PrcIn4	0.916				
PrcIn5	0.951				
PrcIn6	0.889				
ProIn1				0.836	
ProIn2				0.863	
ProIn3				0.831	
QMC1				0.308	0.736
QMC2					0.781
QMC3					0.824
QMC4					0.816
TCpt1			0.785		0.316
TCpt2			0.873		
TCpt3			0.885		
TCpt4			0.881		

The items reported high correlations and the theory of the research is composed of different variables. So, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) is conducted in order to see whether the theory of the research is validated in the data (Tepic et al., 2014, p. 234).Kaiser-Meyer-Olkin Measure of Sampling Adequacy value is 0,842, mentioning that adequate sample size is assessed. Total Variance Explained (TVE) for 5 factors was %80,44 which means that the data has construct validity (Power, 2014, p. 1191). Most of the items are listed under the same factor. However, some of the items reported factor loadings more than 0,3 under more than one factor. Thus, CFA is conducted and some of the items are deleted.

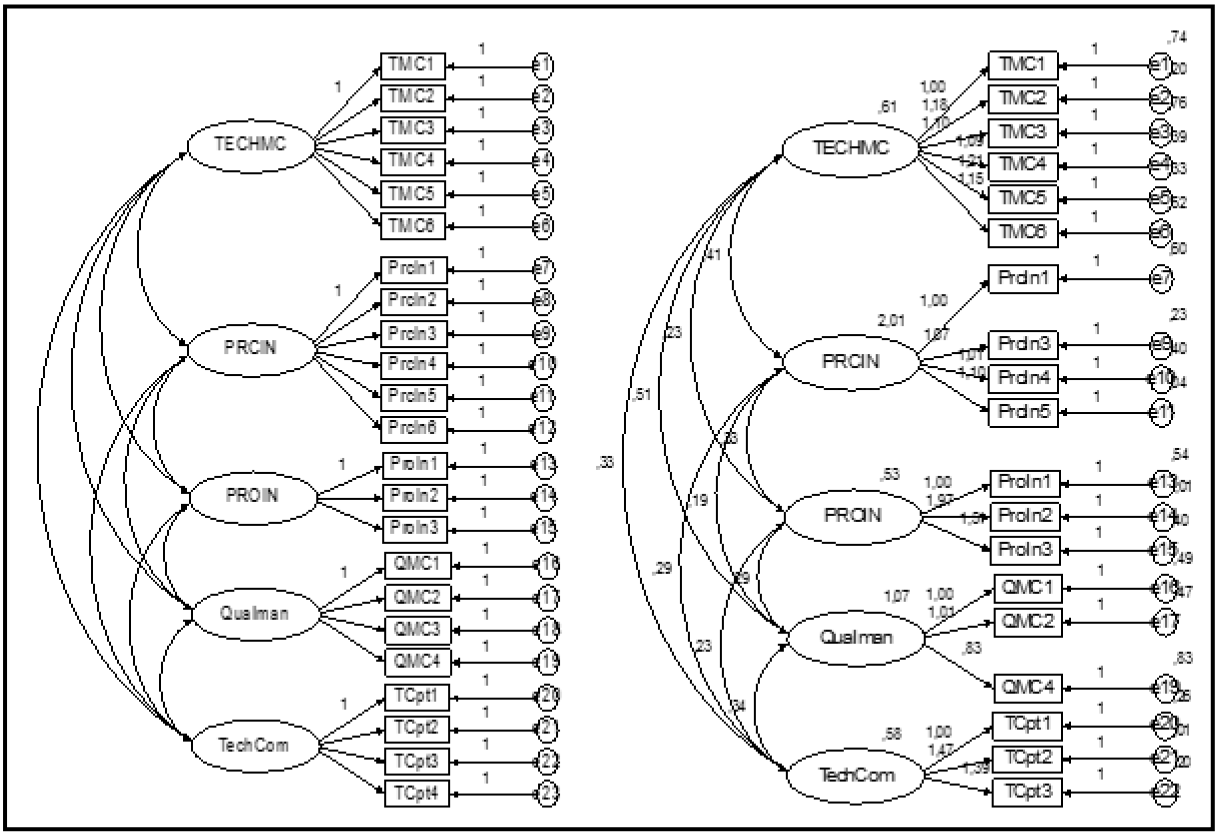

Figure 1. CFA Measurement Models

The initial CFA model failed to meet the acceptable thresholds (CMIN/df=5,159; NFI: ,782; RFI: ,750; IFI:,817; TLI: ,788; CFI:,816; RMSEA: ,142). Then, some of the items reported to fail in EFA and CFA are deleted and the last model met the acceptable thresholds (CMIN/df=3,145; NFI: ,884; RFI: ,861; IFI:,918; TLI: ,900; CFI:,917; RMSEA: ,102).

Table 6. Validity Measures

	CR	AVE	MSV	ASV	Qualman	TECHMC	PRCIN	PROIN	TechCom
Qualman	0.829	0.620	0.404	0.189	0.787				
TECHMC	0.907	0.622	0.404	0.253	0.636	0.789			
PRCIN	0.966	0.876	0.139	0.083	0.127	0.373	0.936		
PROIN	0.898	0.750	0.179	0.148	0.385	0.400	0.323	0.866	
TechCom	0.942	0.845	0.310	0.187	0.432	0.557	0.268	0.423	0.919

By this way, the model is verified. However, there have been concerns of validity. So, the author calculated Average Variance Extracted (AVE), Maximum Shared Squared Variance (MSV) and Average Shared Square Variance (ASV). The AVE for all construct is higher than 0.5.

Moreover Composite Reliability (CR) for all items is higher than AVE (Tepic et al., 2014, p. 250; Liu & Jiang, 2016, p. 892). Furthermore, the ASV and MSV are lower than AVE which means that the model has discriminant and convergent validity.
The covariances between variables are used in order to test the hypotheses (Cordero et al., 2009, p. 305). Accept from one, the other hypotheses are empirically verified.

Table 7. Hypothesis Testing Results

			Estimate	S.E.	C.R.	P	Hypothesis/Result
TECHMC	<-->	PRCIN	.412	.093	4.450	***	H1/Supported
TECHMC	<-->	PROIN	.227	.051	4.488	***	H2/Supported
TECHMC	<-->	Qualman	.512	.086	5.945	***	H3/Supported
TECHMC	<-->	TechCom	.330	.057	5.745	***	H4/Supported
PRCIN	<-->	PROIN	.334	.081	4.101	***	H5/Supported
PRCIN	<-->	Qualman	.187	.113	1.647	.100	H6/Not Supported
PRCIN	<-->	TechCom	.289	.080	3.594	***	H7/Supported
PROIN	<-->	Qualman	.291	.066	4.402	***	H8/Supported
PROIN	<-->	TechCom	.234	.047	4.966	***	H9/Supported
Qualman	<-->	TechCom	.339	.068	4.979	***	H10/Supported

As the significance value is higher than $p<0.05$, except from H6, other hypotheses are verified. These relationships are also found in many former studies (Marcus, 2016, p. 117; Lingren et. al., 2009, p. 17; Fernandez-Mesa et. al., 2013, p. 547; Liu & Jiang, 2016, p. 883; Bergenhenegouwen et al., 1996, p. 29). On the other hand the relationship between process innovation and quality management can be researched in other studies. By applying all of these analyses, the present study proved that the TAM is mostly valid in R&D firms of some TDZs in Ankara.

5. Conclusion, Limitations and Implications

The present study aims to apply TAM in R&D firms in some TDZs in Ankara. With this aim, initially a detailed literature review is carried out. The review revealed many useful information for the methodology of the present work.
Following these findings, the present study employed a questionnaire to a randomly defined sample obtained from different TDZs in Ankara. The results are analyzed in terms of preliminary (frequencies, descriptive statistics and reliability) and in-depth (ANOVA, correlations, EFA, CFA and validity measures) analyses. The results showed that the sample can represent the universe and TAM is mostly valid in R&D firms in some TDZs in Ankara.
Although, the model is statistically proved and the measures for sampling are adequate the present study has some limitations. Initially, the results cannot be generalized to whole Turkish TDZs, as the sample doesn't cover all of them. Another limitation for this research is the number of the firms are not represented equally for each TDZ. However, the number of current firms are not equal either. Moreover, the model failed to explain the relationship between process innovation and quality management. The items used for these constructs can be used in another context. The real effects of R&D firms in macroeconomic context can also be assessed by utilizing the methodology of Şahin (2014, p. 31).
As a result of these analyses, the practitioners of technology management shouldn't focus on only the technology management, but also focus on quality management, process and product innovation and technology competence in an integrative way. Furthermore, the

researchers can make use of the model in different contexts and make use of the empirical findings of the present work.

To sum all up, the present study empirically tested the model and TAM is mostly verified in the study but there is still need for research to understand the technology alliance of different contexts in the huge Turkish R&D production environment. Also, there are some research implications for the academics and some advice for practitioners in technology management.

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