

Developing a Model to Explain the Process of Technology Transfer at Entrepreneurial University

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ABSTRACT

The gap between universities, scientific centers and industrial-production units is one of higher education concerns. In academic entrepreneurship, the university work simultaneously in education, research and entrepreneurship. The universities play a key and important role in providing educational opportunities in economic development. This research aims to develop and expand science as well as help managers to explain the process of technology transfer in entrepreneurial university. This research is applied-developmental type and on the other hand, data driven theories have been used in this study. Current model is generally tried to meanwhile compensate previous shortcomings, include some strengths such as considering domestic factors of Iran as well as update effective factors on the process of technology transfer. Finally the suggested model has been compared with existing well-known models that each one of those models have some drawbacks which have been tried to be minimized in suggested model as much as possible.

Keywords: Technology Transfer, Entrepreneurial University, Open Coding

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1. INTRODUCTION

The gap between universities, scientific centers and industrial-production units is one of higher education concerns. Although the universities have some capabilities and capacities and have always worked due to conducting researches in the form of post graduate students' theses or professors' research plans but the results of conducted studies in industrial-production units are less used (Heydarizadeh *et al.*, 2008). This is while conducting research plans requires spending substantial costs especially in technical-engineering fields which are have to be paid by professors and students. Using and devel-

oping obtained technologies from scientific-research activities in industrial and production processes seem to require taking advantage of some strategies to guarantee their implementation. One of these strategies is technology transfer. Achieving technology in production firms is only possible through transferring technology (Radfar, 2012). Commercialization of university research results is one of important steps of innovation system that guarantee the sustainability of research issue and appropriate with it, in addition to provide noticeable economic values for organizations, it accelerate knowledge-based economic growth of society (Mueller, 2006). There is a well-known component named "entrepreneurial university"

in the center of innovation system. This component is responsible for generating advanced technology and facilitating the process of spreading technology by mediators such as the office of transferring technology as well as creating growth centers and science parks and producing research and development support for existing companies or for helping to create new companies (WalshokL and Shapiro, 2014).

Be mechanism we mean the channels of technology flow that technology which is an intangible phenomenon, will work in case of these channels existence. Main component in the relations of university and industry is transaction which occurs through the mechanisms of supporting researches financially, the permission of spiritual ownership of university, employing the students and establishing new companies. Luck can be also used as an official mechanism (Bercovitz and Feldman, 2006).

Entrepreneurial university needs the managers with specific characteristics of leadership in full time expertise positions for doing its mission (Sporn, 2001). Moreover, this university is vital human resource for developing educational quality and generating innovation in research (Brouwer, 2005). In this field, the managers and academicians are active actors in internal development of traditional universities. Another important factor is financial resource which shows how much a university is independent from government. Various budget means that university has increased its income gained from government support, research contracts, university services, student costs and so on. These resources let passing old boundaries between university and the world around through infrastructures for providing social needs (Clark, 2004). In practice, the location is also an important factor because innovative activities such as the cost of transferring knowledge is a function of geographical distance (Siegel *et al.*, 2003).

It can be said that universities have been involved in commercializing technology since the beginning. Academic researchers in sciences and engineering have always had functional aspect which has led to business exploitation of technologies which are developed in them by university. But academic technology commercializing activities and creating the branches derived from them have had some changes over time. Creating derivational companies has been always a part of university activities, this might be because of functional tendencies of some engineering and sciences fields but these activities have been increased through changing institutional environment and the supports of activities in derivational companies (Lee and Osteryoung, 2004). Leap into the emergence of an “entrepreneurial university” is exceptionally strong, even if its development raise important governance and institutional questions for people involved in it. The concept of entrepreneurial university visualizes the university structure and performance that has been revised through economic development with research and education missions (Etzkowitz, 2000). Some events in Europe such as severe reduction of public budgets in European universities which follow this reduction in America, changes about the role of universities in societies and making the rules of Bai-Dell lawin return for granting invention patent rights in these countries have caused changing the nature of universities (Wright and Mosey, 2007; Baghchesaraei *et al.*, 2015).

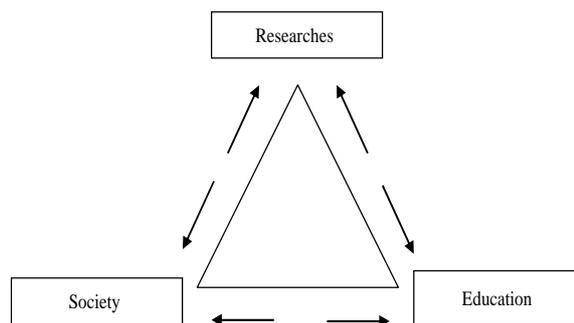


Figure 1. The components of entrepreneurial university mission (Taghizadeh and Mohammadpur, 2008).

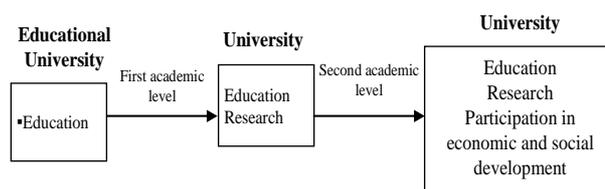


Figure 2. Development in the duties and missions of university.

In the concept of an entrepreneurial university, the universities should do their mission based on three components of education, research and society. Each component has relationship with other ones and if a two-way communication is created and maintained among them, the relationship of entrepreneurial university mission components can be proposed as below.

Education should be based on researches and researches should be formed based on the needs of society. A common criticism which is on university is that university has set back from the real world and do its researches in closed laboratories and has forgotten the real needs of society and the training proposed in university has also reflected this isolation and indicates that these trainings aren't appropriate for real needs of labor market. Labor market is changing, young generation should learn new values named innovation, flexibility and high variety in capabilities. They have to think about creating business and employment for themselves. Therefore, education and research in universities moves toward a direction so that they can support new role of participation in economic development. Generally, development in the duties of universities can be shown in following figure which has been occurred in university following two revolutions:

Producing and exchanging knowledge has become a global process and without creative interaction in international scale, there is no perspective for developing high education. High education in this horizon is expected to follow the patterns of “style science 2” and “big science.” It has to be context-oriented, demand oriented and accountable for national, regional and global markets, it should also think about rational variety of its institutions and try to network (Nemati, 2006; Baghchesaraei and Baghchesaraei, 2014).

2. THE METHODOLOGY AND COLLECTING DATA

To investigate technology, transfer in entrepreneurial university, the following conceptual model which is a combination of Barcovitz and Feldman (Bercovitz and Feldman, 2006) and Guerrero and Urbano (Guerrero and Urbano, 2012) is suggested.

2.1 Statistical Population

Statistical population of current study includes academic elites (the professors of technology management in Azad Islamic university of Tehran, Tabriz, Arak and Isfahan industrial poles) who have relative dominance on the subject of research. These elites were asked about this issue:

2.2 Statistical Sample

Statistical analysis unit of this research in grounded theory theorizing method includes 9 elites of technology management in big units of Islamic Azad University of Tehran, Tabriz, Arak and Isfahan industrial poles because not to damage research in terms of credit on one hand and avoiding data diffusion on the other hand.

2.3 The Method and Tools of Data Collection

To collect information in this research, field studies,

library studies and checklist, questionnaires and interview have been used.

2.4 The Method of Analyzing Data

In this research, grounded theory method is used. After coding obtained data and passing the levels of research methodology based on grounded theory, the model below which explains the process of transferring technology in Entrepreneurial University was obtained. Figure 3 shows the final model, which is obtained from current research.

General approach in this research is that very exists in grounded theory that is using an approach based on data but for richness of the themes and concepts, the themes which have been related to the title of research in the past, through comprehensive investigation of them, are extracted and used in coding process. Therefore, the approach which is used in this research is either inferential or taking advantage of approach based on past researches and reviewing the literature. Strauss and Corbin (1990) suggest three levels of coding for theorizing grounded theory which include:

- Open coding
- Axial coding
- Selective coding

2.5 Open Coding

To determine the concepts, theoretical principles

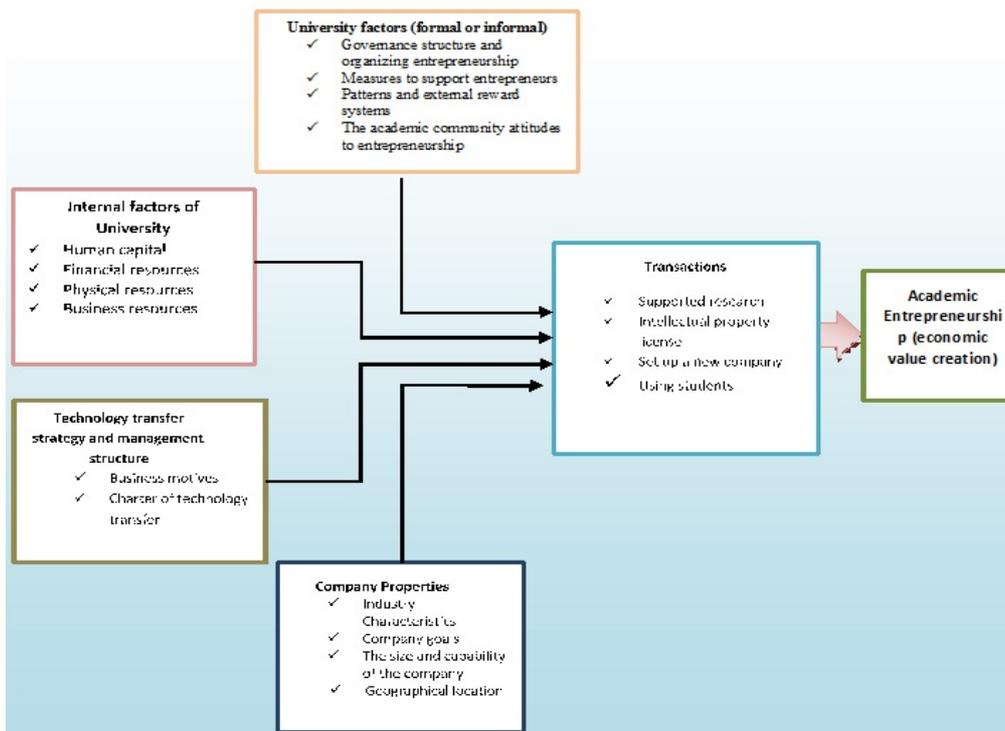


Figure 3. Suggested model of research for the process of transferring technology in entrepreneurial university.

around the subject should be collected as the first step. The statistical population for doing grounded data theory includes a combination of theoretical principles of subject (extracted from relevant literature) and deep interviews which have been obtained from the elites of university and industry and model has been extracted from them. That is because of unknown real process technology transfer in Entrepreneurial University. The information in this research has been collected through deep interview as leading general interview guide approach and semi structural interview. In these interviews in which the time was variable between 30 to 70 minutes, the subjects of conversation were given to the interviewees to be able to participate in the session fully ready and propose the intended information. All accomplished interviews were recorded and the context of interviews was implemented and each one of interviews was analyzed immediately. Moral considerations were also noticed in running the research that in fact showed how the interviewees were respected by the researcher (Gorard and Taylor, 2004; Baghchesaraei *et al.*, 2016; Ndonzuau *et al.*, 2002). Related to this, with the questions of interview, the interviewees were also given a commitment with the signature of researcher to this content that the researcher is morally committed to keep the content of interview and characteristics of interviewees secret and because of this and ensuring interviewees that their information and characteristics won't be revealed, the atmosphere of interview was a very scientific one without any consideration in proposing information. Data were revised and refined based on three-level coding of open, axial and selective constantly and based on the similarities and origin of data, a set of similar data were gathered around a concept in an inferential process.

The concepts which had common meaning were organized in the form of subjects which have more abstract level than concepts and finally the subjects whose meaning and content were more similar were categorized under a particular class. In grounded theory method, analyzing data means continues comparison of data aiming to conceptualize and it includes all levels from coding to classifying. This method makes creation of theory possible through direct systematic coding and analytical

methods. This process includes three types of comparisons. The phenomena are first compared to each other for discovering the similarities and how they change in various conditions.

Considering the questions which some of them were mentioned, particularly sensitive ones, open coding level started in current research. Various resources were used in the open coding level that Table 1 indicates the used resources and after accurate study and investigation, the relevant points to technology transfer in entrepreneurial university and its requirements were extracted as notes. The result of this process are notes which were considered as initial data that the concepts were extracted from their hearts. Table 2 show these initial concepts.

According to Strauss and Corbin (Strauss and Corbin, 1990), when the contents are created, the analysis needs to group them under the words with more explanatory power which are called topic. When a topic is recognized, reminding it, thinking about it and moreover explaining the features and aspects of that will be more easily. Therefore, in this step, through comparison process, the similarities and differences of extracted concepts from interviews, news and reports were extracted and investigated and the similar concepts were groups in one category. It has to be noticed that this level has been done focusing on the questions which are located in the class of theoretic questions.

The formation of subjects in open coding guided selection of questions in later interviews and the direction of questions selecting led to the order and consequence of topics. Table 3 introduces related topics to each category of concepts.

After identifying the concepts and topics in current research, the existing topics were divided into micro topics according to Strauss and Corbin (1990). Micro topics propose more information about how and why of a phenomenon and help more transparency of a topic through this.

3. RESULTS

Suggested model of Siegel *et al.* (2003), for the

Table 1. The resources of collecting data in the research

Count	Resources	Number
9	Exclusive interview with IT management experts	1
12	The written interviews of media with Ministers of Science and Technology, Industry and Mining in the Government related to the research subject	2
6	Video interviews of media with Ministers of Science and Technology, Industry and Mining in the Government related to the research subject	3
3	Radio interviews of media with Ministers of Science and Technology, Industry and Mining in the Government related to the research subject	4
18	Other documents, texts and reports related to research, including analyses, news and reports	5
15	Reminder notes from the process and observations during the study	6

Table 2. Extracted concepts from the statements

Statement code	Statement	Number
A1	The government's desire to market.	1
A2	Stable and real rate of exchange and interest	2
A3	Low inflation	3
A4	Development of effective policies on technology transfer by policymakers in the country	4
A5	Accurate and up to date law in intellectual property rights	5
A6	The willingness of countries to transfer technology to Iran	6
A7	Promoting the culture of supporting internal product by media	7
A8	Deep understanding of the needs of the community	8
A9	Promoting the spirit of risk-taking in society	9
A10	Promoting a culture of teamwork	10
A11	Close cooperation between the entrepreneurial university, industry and government centers	11
A12	Enactment of appropriate legislation to increase the risk-taking investment	12
A13	The educational system aims to increase the entrepreneurial spirit in students	13
A14	Training internal experts	14
A15	Determining the research and development team in collaboration with the University of entrepreneurs and partner industrial centers	15
A16	Signing contract between entrepreneurial university and volunteer industrial centers	16
A17	The widespread use of informal methods of technology transfer, including scientific and technical exchanges in attracting new technologies by entrepreneurial university and selling it to industrial centers	17
A18	Statutory tax system in order to support the entrepreneurial university contracts	18
A19	Technology Transfer Office at the entrepreneurs university	19
A20	Office of Industrial Relations at the University of entrepreneurs	20
A21	The ability of academic centers in meetings, presentations and conferences.	21
A22	High potential for training internal experts	22
A23	Having young labor force looking for work	23
A24	Careful required feasibility studies about internal required technologies	24
A25	Coping with oil-based economy and the crisis of falling oil prices	25
A26	Production and commercialization of the technology to produce and sell more	26
A27	Achieving economic stability for increasing risk-taking investment	27
A28	appropriate field of importing capital goods in the country	28
A29	Regarding the technology life cycle proposed to transfer	29
A30	Accurate determination of appropriate methods of technology transfer from entrepreneurship university to fellow industrial centers	30
A31	Attracting more priority technologies	31
A32	selected technology being in accordance with the terms of the industry centers	32
A33	Industrial center active participation in all stages of the process of technology transfer	33
A34	Keeping pace with the rapid technological progress in the world.	34
A35	Accessing to a market with high potential for technological products in Iran	35
A36	Cheap advanced technology absorption to produce technological products by industrial centers	36
A37	Effective management of industrial cooperation centers with the entrepreneurial university	37
A38	Close cooperation between the entrepreneurial university and industrial centers	38
A39	Economic incentives for technology transfer in industrial centers	39
A40	closeness of the industrial center to the fellow entrepreneurs University	40

A41	Holding regular meetings between entrepreneurs university and industrial center of colleagues at the University	41
A42	The possibility of installing and furnishing the required equipment in the industrial center working with the Entrepreneurial University	42
A43	Identification of strategic industries in entrepreneurial university	43
A44	Shortening the learning curve in the product	44
A45	Supporting the transition process by Technology Transfer Office of entrepreneurial university	45
A46	Centralized policy of technology transfer in Iran	46
A47	Special attention to research and development activities in the industrial centers working with the Entrepreneurial University	47
A48	Promoting innovation in society	48
A49	Attracting foreign investors to enter into technology	49
A50	The entry of country's oil revenues to the field of technology transfer and production in Iran	50
A51	Strengthening the export promotion policy in Iran	51
A52	Promotion and dissemination of scientific achievements	52
A53	Public Participation	53
A54	Research projects and study opportunities	54

Table 3. Micro topics

Topic code	Topic	Statement code	Statement	Number
B1	Governance structure and entrepreneurial organizing	A1	The government's desire to market	1
		A2	Stable and real rate of exchange and interest	2
		A3	Low inflation	3
B2	Supporting measures from entrepreneurship	A4	Development of effective policies on technology transfer by policymakers in the country	4
		A5	Accurate and up to date law in intellectual property rights	5
		A6	The willingness of countries to transfer technology to Iran	6
B3	External patterns and reward system	A7	Promoting the culture of supporting internal product by media	7
		A8	Deep understanding of the needs of the community	8
		A9	Promoting the spirit of risk-taking in society	9
B4	The attitude of academic community to entrepreneurship	A10	Promoting a culture of teamwork	10
		A11	Close cooperation between the entrepreneurial university, industry and government centers	11
		A12	Enactment of appropriate legislation to increase the risk-taking investment	12
B5	Human capital	A13	The educational system aims to increase the entrepreneurial spirit in students	13
		A14	Training internal experts	14
		A15	Determining the research and development team in collaboration with the University of entrepreneurs and partner industrial centers	15
B6	Financial resources	A16	Signing contract between entrepreneurial university and volunteer industrial centers	16
		A17	The widespread use of informal methods of technology transfer, including scientific and technical exchanges in attracting new technologies by entrepreneurial university and selling it to industrial centers	17
		A18	Statutory tax system in order to support the entrepreneurial university contracts	18
		A19	Technology Transfer Office at the entrepreneurs university	19
		A20	Office of Industrial Relations at the University of entrepreneurs	20

B7		A21	The ability of academic centers in meetings, presentations and conferences.	21
B8	Business resources	A22	High potential for training internal experts	22
		A23	Having young labor force looking for work	23
		A24	Careful required feasibility studies about internal required technologies	24
B9	Business motives	A25	Coping with oil-based economy and the crisis of falling oil prices	25
		A26	Production and commercialization of the technology to produce and sell more	26
		A27	Achieving economic stability for increasing risk-taking investment	27
B10	Technology transfer character	A28	appropriate field of importing capital goods in the country	28
		A29	Regarding the technology life cycle proposed to transfer	29
		A30	Accurate determination of appropriate methods of technology transfer from entrepreneurship university to fellow industrial centers	30
B11	The characteristics of industry	A31	Attracting more priority technologies	31
		A32	selected technology being in accordance with the terms of the industry centers	32
		A33	Industrial center active participation in all stages of the process of technology transfer	33
B12	The goals of company	A34	Keeping pace with the rapid technological progress in the world.	34
		A35	Accessing to a market with high potential for technological products in Iran	35
		A36	Cheap advanced technology absorption to produce technological products by industrial centers	36
B13	The size and capability of company	A37	Effective management of industrial cooperation centers with the entrepreneurial university	37
		A38	Close cooperation between the entrepreneurial university and industrial centers	38
		A39	Economic incentives for technology transfer in industrial centers	39
B14	Location	A40	closeness of the industrial center to the fellow entrepreneurs University	40
		A41	Holding regular meetings between entrepreneurs university and industrial center of colleagues at the University	41
		A42	The possibility of installing and furnishing the required equipment in the industrial center working with the Entrepreneurial University	42
B15	Supported researches	A43	Identification of strategic industries in entrepreneurial university	43
		A44	Shortening the learning curve in the product	44
		A45	Supporting the transition process by Technology Transfer Office of entrepreneurial university	45
B16	Intellectual ownership license	A46	Centralized policy of technology transfer in Iran	46
		A47	Special attention to research and development activities in the industrial centers working with the Entrepreneurial University	47
		A48	Promoting innovation in society	48
B17	Setting up new company	A49	Attracting foreign investors to enter into technology	49
		A50	The entry of country's oil revenues to the field of technology transfer and production in Iran	50
		A51	Strengthening the export promotion policy in Iran	51
B18	Using the students	A52	Promotion and dissemination of scientific achievements	52
		A53	Public Participation	53
		A54	Research projects and study opportunities	54

process of academic entrepreneurship is a linear model which has 7 levels. This model has regarded academic entrepreneurship as a process which has 7 levels. Since this model is seen linearly, it cannot explain all the aspects of academic entrepreneurship correctly.

Gorard and Taylor (2004) introduced four levels related to converting the results of academic researches to economic value of course through derivational companies. Unlike the previous one, this model has considered each one of four levels as a process. The weakness of this model is that each one of processes affect each other linearly and have a one-way relationship.

Barcovitz and Feldman have proposed a model for investigating the process of academic entrepreneurship. This model has eliminated the weaknesses of the previous model to the great extent but social and cultural barriers haven't been noticed in this model while according to the existing literature and accomplished studies, these cases can also change the process. On the other hand, the process of technology transfer hasn't been recognized exactly.

Guerrero and Urbano (2012), proposed another model for investigating the process of transferring technology in entrepreneurial university which has significant comprehensiveness compared to the other models. This model hasn't noticed the development of global markets, on the other hand the process of technology transferring hasn't also been recognized very well but beside the model of Barcovitz and Feldman, it can be an appropriate framework for studies in this case.

4. CONCLUSION

4.1 The Comparison of Proposed Model with Existing Well-Known Models

Proposed model in this part has some differences with proposed models up to now as follows:

- a) Siegel *et al.* (2003), for the process of academic entrepreneurship is a linear model which has 7 levels and a one-way process in whole model while in proposed model, there are 14 levels of process only in central topic part. Moreover, the other factors in proposed general model haven't been considered in the model of Siegel *et al.*
- b) The model of Gorard and Taylor (2004) is a four-level model and this model only seek to convert the results of academic researches to economic value. This model has a one-way process of 4 levels. The weakness of this model is that each one of processes affect each other linearly and have a one-way relationship. Moreover, environmental factors haven't also been considered while these factors have been discussed and investigated in proposed model. In model of Gorard and Taylor (2004) converting academic researches to economic value is only con-

ducted through derivational companies.

- c) In model of Barcovitz and Feldman, the process of transfer has been seen two-way in all cases but the process isn't explained clearly and the beginning and ending aren't clear but in proposed model the beginning and ending of process are clearly shown.
- d) Suggested model by Guerrero and Urbano hasn't explained transferring technology as process, this is while this subject has been carefully studied in the proposed model in this research. In their model, Guerrero and Urbano have tried to mention two categories of internal and external factors effective on process that considering the importance and variety of effective factors on the process, the current proposed model has carefully investigated 5 categories of factors. Moreover, current model has also noticed other effective factors plus to effective internal factors.

Current model has been generally tried to include some strengths such as considering internal factors of Iran as well as update and effective factors on the process of transferring technology in addition to compensate the drawbacks of previous models.

4.2 Evaluation of Grounded Theory

Strauss and Corbin have discussed three aspects about evaluation criteria of grounded theory. First data trustfulness and reliability, second evaluating the satisfaction of research process and third judgment about empirical basis of research findings (Baghchesaraei *et al.*, 2016). They discussed 7 questions as some criteria about the basis of experience in study in which the way of responding to them is a criterion for evaluating and shows how much the experiences are empirical. The researcher answers the questions in his own point of view and lets others to have final judgment about the quality of research.

- Have the concepts been created?

In the process of working with data and after coding, the codes or relevant signs are extracted from the data and by juxtaposing relevant and similar codes and attributing abstract words, the concepts are created and after that the topic are formed.

- Are the concepts systematically connected to each other? Extracted concepts are connected to each other and topics are formed through juxtaposing them. Though juxtaposition of 54 concepts which form 18 topics, the basis of grounded theory formation has been created.

- Are the topics expanded well?

The set of extracted topics from concepts are located in six categories. The concepts and topics have been tried to have adequate conceptual concentration and bring relevant codes for describing each one of samples.

- Is there high variety inside the theory?

Gathering data from different resources has helped the theory to have variety.

- Do wider terms which affect the phenomenon of study are considered in explanations?

In order to consider wider terms affecting the phenomenon, the data are gathered out of various resources and the ideas of technology management elites aren't the only things which have been noticed. The cases which couldn't be achieved by elites, are considered in paradigm through gathering documents, voices and films related to subject.

- Do theoretical findings make sense?

Proposing grounded theory has become meaningful through visualizing model as well as juxtaposition and describing the topics.

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