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RESEARCH PAPER

Learning in Research Collaborations With Universities: The Case Study of Iranian Oil, Gas, and Petrochemical Industries

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Abstract
Learning in collaboration projects with universities is one of the common methods in recent decades. Some of these projects have led to learning for industries, while others have suffered from a lack of learning. Most of the studies that have examined the dimensions and factors affecting the performance of these projects have been done in developed countries. However, considering the different nature of learning in developing countries, this issue needs more attention. This paper addresses two basic issues, namely the factors that affect the learning of companies in collaboration projects with universities in developing countries and the things that industries in these countries learn from universities. To answer these questions, 9 collaboration projects with universities in Iranian oil, gas, and petrochemical industries were selected, 15 experts active in the industry, academia, and government related to these projects were interviewed, and the data was analyzed by thematic analysis. Twenty five factors affecting learning were classified into 6 groups, the most important of which were collaboration control mechanisms, rules and procedures, university business model, degree of partnership between the parties, fitness of the content of the collaboration to the industry features, trust between the parties, and competence of the university team leader. The results also showed that companies in developing countries usually pursue exploitative learning in collaboration projects with universities. In these countries, mature industries active in older technologies typically pursue exploitative learning, and new technology-based firms seek explorative learning in collaborations.

Keywords: explorative learning, exploitative learning, university-industry collaboration, research collaboration project.

1. Introduction

Learning has been studied in different fields of research; however, organizational learning received more attention in the 1990s, when the pace of development of new markets and technologies increased (Antunes & Pinheiro, 2019). Peter Senge (1990) stated that there are so many challenges in the field of organizational science that past knowledge and strategies cannot guarantee future success. Organizational learning resulting from these challenges has become a necessity for companies to use it to increase their resources and skills and achieve sustainability in competitive advantage.

In one category, organizational learning types based on the source of knowledge creation are divided into two extensive categories of intra-organization and inter-organization learning. If learning takes place through teams and units within the organization, this learning or knowledge transfer is interpreted as intra-organization learning. If the source of knowledge is

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outside the organization, such as networks, collaborations, consulting, suppliers, and customers, it is interpreted as inter-organizational learning (Dzhengiz, 2020). Among inter-organizational learning, one of the most common in recent decades is the learning of industrial companies in collaboration projects with universities.

With the growing importance of learning in university-industry collaboration in recent years, numerous studies have examined the factors affecting it. Petruzzelli (2011) examined the impact of factors including partners' technological dependencies, prior relationships, and geographical distance on industry-university collaboration. Chen et al. (2019) inspected the impact of intra-regional and inter-regional political boundaries on the performance of industry-university collaboration. In another study, Ting et al. (2018) investigated the impact of researcher competence on industry-university collaboration. In addition, some studies have categorized the learning of companies resulting from research projects with universities. For example, Clauss and Kesting (2016) introduced knowledge acquisition in collaborations in the form of three categories: knowledge combination, learning, and knowledge creation. These concepts, respectively, mean the combination of external and internal knowledge, the acquisition of the other party's knowledge, and the creation of knowledge in collaboration. Bishop et al. (2011) presented the learning resulting from these collaborations as two diverse categories, namely explorative learning and exploitative learning, and offered the indicators of each category in the context of a developed country.

Iran is one of the developing countries. Learning in most developing countries differs from developed countries in two major ways. First, companies in developing countries lack technical knowledge. Second, since most companies are followers, technological learning should have a more dynamic nature (Miri Moghaddam et al., 2015).

In addition, the different contexts of developing countries make them different in terms of issues and challenges, and this can lead to differences in the factors affecting learning in industry-university collaboration. In most developing countries, like Iran, university revenues are heavily dependent on government budgets, and the share of the revenue resulting from collaboration with industry is small. This can affect their tendency to transfer knowledge to the industry. Moreover, control over the allocation of resources and the results of collaborative projects have been largely delegated to professors, and universities have little control over them. These can affect the quality of knowledge transferred to the industry. Industry in developing countries also has a major difference with developed countries. Most large companies in these countries are state-owned. Of course, there are small and medium-sized non-governmental industries, but it seems that these industries are not very willing to cooperate with universities. Therefore, most university-industry collaborations, especially in the oil, gas and petrochemical industries, are carried out with large state-owned companies. In addition, in these countries, the number of leading companies is low, and as a result, there is a weaker competitive environment between companies in a sector. These two issues can affect the motivation and accuracy of organizations in controlling collaborations and can affect learning. Moreover, in these countries, institutions, laws, and procedures are immature, and this can affect learning in collaboration.

Reviewing previous research, it seems that the factors affecting learning in university-industry collaboration in developing countries have not been comprehensively studied. Therefore, given the differences in the challenges and the nature of technological learning, further study of this issue in the context of these countries seems necessary. It also seems that the dimensions of learning in university-industry collaboration in a developing country have not been comprehensively examined.

Therefore, due to budget constraints and the importance of promoting industry learning, this paper addresses two basic issues:

- What factors affect the learning of companies in collaboration projects with universities in developing countries?
- What do industries in these countries learn from universities?

To answer these questions, nine collaboration projects with universities in Iran's oil, gas, and petrochemical industry were selected; 15 experts active in the industry, academia, and government related to these projects were interviewed; and the collected data was analyzed via thematic analysis.

The remainder of the paper is structured as follows. Section 2 presents research background. Section 3 is devoted to methodology. Section 4 presents the analysis of the case study and its results. Section 5 provides the discussion and conclusions of the study. Section 6 provides the implications, and finally, Section 7 presents the limitations and suggestions for future research.

2. Research Background

According to the research questions, the literature review is divided into two parts.

The first part is about the factors that affect the industry learning in research collaborations with universities. Oliver et al. (2019) examined the effect of trust (individual and organizational) between industry and academia on learning in collaboration between them. Schultz et al. (2021) showed that partners' shared R&D-project innovativeness perceptions increase the performance of university-industry collaboration projects. They also demonstrated the positive impact of collaborative planning on shared perception. Clauss and Kesting (2016) studied the impact of management mechanisms (based on transaction cost theory or social exchange theory) on knowledge sharing and achieving common goals in industry-university partnerships. Lopes and Lussuamo (2021) examined barriers to industry-university collaboration in Angola. They cited lack of inter-organizational trust and low level of experience as frequent barriers to this type of collaboration.

Bishop et al. (2011) examined the acquisition of corporate interests from universities and called it learning. They assessed the impact of three factors – namely the firm's greater commitment to research and development, geographical proximity to academic partners, and the research partner's research quality – on explorative learning and exploitative learning. Tseng et al. (2020) examined the factors influencing industry-university collaboration in Taiwan. They examined the impact of four factors of government and industry funding, management mechanisms, innovation climate, and reward system on the innovation performance of universities. Subramanian et al. (2018) examined the role of knowledge-based similarity in learning from strategic partnerships. They concluded that there is an inverse U-shaped relationship between technological distance and inter-organizational learning. Garcia et al. (2018) examined the relationship between geographical proximity and perceptual proximity in industry-university collaboration in Brazil. They concluded that perceptual proximity could replace geographical proximity and contribute to the success of the collaboration. Chen et al. (2019) examined the impact of intra-regional and inter-regional political boundaries on the performance of industry-university collaboration. Using a three-stage model, Parmentola et al. (2021) examined the motivations, barriers, and channels of university-industry collaboration in a low-innovative region of Italy and compared them to high-innovation areas. Fernandes et al. (2020) examined critical factors for benefits realization in collaborative university-industry R&D programs. They examined 66 key factors and found that the most key factors are related to three areas, i.e., strategic, inter-relational, and cultural arenas.

In general, after a comprehensive review of the research background on the factors

affecting the performance of collaboration, a classification consisting of six groups can be presented. In some studies, the characteristics of the university – such as the university quality, the university motivation, and the innovation environment – have been studied as an effective factor in learning. Other studies have focused on the characteristics of the other party, namely industry, including senior management support, management mechanisms, absorptive capacity, and industry motivation. Another group of studies has examined how the parties relate to each other and has examined factors such as geographical distance, trust, common scientific basis, and homogeneity in goals and procedures. Another group has investigated factors related to the collaboration environment, such as government budget support, intellectual property rights, and political boundaries. In addition, some studies have inspected the impact of the collaboration content, such as the relationship between the issue and the central competence of the parties, the level of innovation and complexity of the collaboration issue, the parties' familiarity with the issue, and its priority for the industry. Finally, some studies have explored the impact of collaboration team members' characteristics such as researcher competence, motivation, and mutual understanding between members on the performance of industry-university collaboration. These categories are listed in Table 1.

It seems that among the characteristics of the university, the impact of factors such as the dependence of universities on public budget and collaboration control mechanisms have not been considered in previous studies. In addition, the impact of collaboration control mechanisms by the industry needs further investigation. In addition, it seems that the effect of government institutions, laws, and procedures as well as that of the competitive environment of industry on corporate learning in collaboration with universities has not been studied.

Table 1. Factors Affecting the Performance of University-Industry Collaboration

Factor	Sub-factor	References
University features	University quality	Fernandes et al. (2018)
	University motivation	Bhullar et al. (2019)
	Innovation environment	Huang & Chen (2016)
Industry features	Senior management support	Ting et al. (2018)
	Management mechanisms	Clauss & Kesting (2016)
	Absorptive capacity	Fernandes et al. (2018)
	Industry Motivation	Fang et al. (2011)
Industry and university communication features	Geographical distance	Garcia et al. (2018)
	Trust	Oliver et al. (2019)
	Common scientific basis	Subramanian et al. (2018)
	Homogeneity	Estrada et al. (2016)
Collaboration environment features	Government budgets	Ankrah et al. (2015)
	Intellectual property rights	Lhuillery & Pfister (2009)
	Political boundaries	Chen et al. (2019)
Content features	Relation to core competence	Dooley & Kirk (2007)
	Level of innovation and complexity	Villani et al. (2017)
	Familiarity with the subject	Sherwood & Covin (2008)
	Priority for industry	Dooley & Kirk (2007)
Collaboration team members' features	Researcher competence	Ting et al. (2018)
	Mutual understanding	Barbolla & Corredera (2009)
	Number of members	Huang & Chen (2016)
	Motivation of members	Janowicz-Panjaitan & Noorderhaven (2008)

The second part deals with the dimensions of companies' learning in research collaborations with universities. Minbaeva et al. (2018) measured the learning of industrial

companies in research collaborations with universities through six parameters, i.e., written managerial knowledge, technical manuals and guidelines, new market specialties, knowledge of foreign cultures and tastes, knowledge related to management procedures, and knowledge gained from observing the work processes of the other party. Clauss and Kesting (2016) defined three types of knowledge sharing in industry-university partnerships, namely knowledge combination, learning, and co-poiesis. In knowledge combination, external and internal knowledge are combined. Learning means the direct acquisition, use, and internalization of the other party's knowledge, and the creation of knowledge is related to the knowledge created in collaboration. Fang et al. (2011) introduced the process of communicative learning in collaboration, including the three stages of knowledge sharing, joint sense-making, and relationship-specific memory. Huikkola et al. (2013) have adopted the same definition of learning in industry-university partnerships.

Inkpen and Tsang (2005) presented several types of collaborative learning from different dimensions as follows. In one dimension, collaborative learning includes technological learning, managerial knowledge, and market knowledge. On the other hand, learning in partnerships includes two types: one type of knowledge is jointly created in partnerships by two partners, and the second type is the knowledge that each partner enters collaboration and the second party can use it. On the other hand, as in other sciences, there are two types of knowledge in collaboration, namely explicit knowledge and tacit knowledge. Janowicz-Panjaitan and Noorderhaven (2008) considered inter-organizational learning to have two dimensions: (a) increase in knowledge inventory which includes service/ product technology, company management, information technology, human resource management, customer service, market knowledge, and financial management, and (b) changes in company behavior that include applying knowledge and improving productivity. Sherwood and Covin (2008) equated learning in collaboration with the acquisition of tacit and explicit knowledge. Tacit knowledge includes unwritten rules for technology, unspoken methods for implementing technology, unspoken methods for problem-solving, and unwritten rules for applying technology. Explicit knowledge includes written specifications of the technology, step-by-step methods for problem-solving, quality control documents, and technology development documents. Finally, Bishop et al. (2011) defined the dimensions of industry learning in research collaborations with universities, including exploratory learning and exploitative learning. Exploratory learning means the ability to identify and interpret information related to research, and exploitative learning means the ability to apply knowledge in company activities. The term explorative and exploitative learning in collaboration has been used with the same definition in Ribin's (2020) research.

3. Research Methodology

This research was conducted with a qualitative approach and thematic analysis method. The level of analysis was the research collaboration projects between industry and academia, and the unit of analysis was the people who conducted these projects in industry or academia.

3.1. Case Selection

Since methods based on chance and probability cannot be used for in-depth study and cases needed to be selected carefully and purposefully (Benbasat et al., 1987) in the present study, the purposive sampling method was used. Due to the basic concepts of qualitative research, the number of samples was not determined before the research and the sampling process

continued until theoretical saturation was achieved. The sample selection strategy was as follows.

1. The first project was selected after consulting the former director of research and technology of the gas company.
2. The selection of the next projects was determined through the snowball strategy.
3. The projects were selected so that their completion time was between 2015 and 2019.
4. Attempts were made to include all three sectors of Iran's oil, gas, and petrochemicals.
5. The selected cases were collaboration projects between the mentioned industries with the top universities as ranked by the Ministry of Science, Research, and Technology.
6. In each project, the main project manager in the industry and the project manager in the university (university professor) were interviewed (although in three projects, the conditions for interviewing the professor were not provided).
7. It was tried to select projects that entailed professors who both were working in the university and had a position in policy-making.

By the time the sampling attained theoretical saturation, the number of sample projects had reached nine. In six of these projects, one interview was conducted with the project manager in the industry and another interview was conducted with the university professor. In the other three projects, only the interview with the project manager in the industry was done. Thus, the number of interviews reached fifteen. In addition, it is noteworthy that three professors worked both in the university and as policymakers in Iran. The description of the interviewees can be seen in Table 2.

3.2. Data Collection

Data was collected through in-depth and semi-structured interviews. In each project, an attempt was made to interview the project leader in both industry and academia. At the beginning of the interview session, the purpose of the research was briefly explained to the interviewees. Research questions were asked from the interviewees in two general sections. The first part contained six questions. In these questions, the interviewees were first asked about the things that industries learn from universities in research collaborations. They were then asked if specific categories could be offered for the learning. Differences between different countries or industries in terms of these types of learning were also questioned. The second part consisted of eight questions. In these questions, the interviewees were first asked about the general factors influencing the learning of the industries in collaborations with the universities. Then, according to the classification obtained from the research background, they were asked about the factors affecting learning in terms of university characteristics, industry, communication, environment, content, and members of the collaboration team.

3.3. Data Analysis

According to Braun and Clarke (2006), a six-stage procedure was followed, namely familiarizing with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. Therefore, after fully implementing the interviews, the concepts were extracted from these interviews, which then shaped the initial codes that were attached to sub-themes. Then, by searching and reviewing them, some themes were extracted, named, and finally reported in tables 3 to 6. Accordingly, concerning the dimensions of learning (what industry learns in research collaboration projects with the university), eleven sub-themes were extracted, and then in secondary coding, similar and common concepts and items were classified into two themes, including explorative learning and exploitative learning. Concerning the factors

affecting learning (what affects the learning of companies in research collaboration projects with universities), twenty-five sub-themes were identified, which were categorized into six themes, namely industry features, university features, collaboration environment features, industry and university communication features, content features, and collaboration team members' features. MAXQDA 2020 software was used for data analysis.

3.4. Trustworthiness

For the trustworthiness of qualitative studies, four criteria have been proposed by Guba and Lincoln (1989), which are credibility, transformability, conformability, and reliability. Credibility was done by triangulation and using three data sources – including project managers in industry, university professors, and policymakers – to examine different perspectives and obtain more comprehensive data on the dimensions of learning of industrial companies and the factors affecting it in research collaborations with universities. In addition, the transformability of research results was achieved through the purposive sampling method and efforts to achieve rich data. The criterion of conformability was met through data collection through in-depth interviews and long-term engagement with the data and their categorization and conceptualization. To achieve reliability, some interviews were entrusted to two experts to check their agreement with the coding.

Table 2. Description of the Interviewees

Project number	Industrial sector	Interviewee on the industry side	Interviewee on the university side	Position of professor in policymaking
1	oil	Project manager	Professor	Director-general of the Industry Liaison Office of the Ministry of Science, Research, and Technology
2	oil	Project manager	Professor	-
3	oil	Project manager and head of R&D	Professor	Former member of the Deputy Minister of Science and Technology
4	gas	Project manager	Professor	-
5	gas	Project manager and director of R&D	-	-
6	gas	Project manager	-	-
7	Petrochemical	Project manager and director of R&D	Professor	Member of the Deputy of Science and Technology
8	Petrochemical	Project manager	Professor	-
9	Petrochemical	Project manager	-	-

4. Finding

4.1. Dimensions of Learning

According to the phases of the thematic analysis process mentioned by Braun and Clarke (2006), to identify the learning dimensions of industrial companies in research collaboration projects with universities in general, two themes (including explorative learning and exploitative learning) and 11 sub-themes were identified, each of which is described below. The results of the analysis using MAXQDA software for themes and sub-themes of learning dimensions are given in Table 3. The method proposed by Fontanella et al. (2011) was used to measure saturation. In this method, the number of newly identified sub-themes in each

interview is determined. Theoretical saturation is obtained when this value is equal to zero in several consecutive interviews. As can be seen in Table 4, no new code has been identified for the learning dimension since interview 9.

Table 3. Frequency of Themes and Sub-Themes for the Learning Dimensions

Subject	Frequency	Themes	Frequency	Sub-themes	Frequency
Learning dimensions	88	Explorative learning	36	Creating an article	10
				Creating a patent	12
				Theoretical knowledge creates opportunities for the future	9
				Generating creativity and ideas	5
		Exploitative learning	52	Problem identification and solution	13
				Reverse engineering of a product	5
				Reducing product/ process costs	7
				Increasing product/ process quality	10
				Product/ process innovation	9
				Improving equipment utilization knowledge	4
				Improving the capacity of personnel	4

Table 4. The Results of the Theoretical Saturation Measurement for the Learning Dimensions

	Interviews														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Creating an article	×	×	×		×	×		×	×	×	×		×		×
Creating a patent	×	×	×	×		×	×		×	×		×	×	×	×
Theoretical knowledge creates opportunities for the future		×		×		×	×	×			×			×	
Generating creativity and ideas								×		×			×	×	
Problem identification and solution	×	×		×	×	×	×	×	×		×	×	×	×	×
Reverse engineering of a product			×		×			×					×		
Reducing product/ process costs				×	×	×			×		×		×		×
Increasing product/process quality	×	×	×		×		×	×		×		×	×		×
Product/ process innovation	×		×	×	×	×		×							
Improving equipment utilization knowledge							×		×		×		×		
Improving the capacity of personnel						×		×			×			×	
New codes in each interview	5	1	1	1	0	1	1	1	0	0	0	0	0	0	0

According to experts, the first category of learning (i.e., explorative learning) is related to the cases in which companies acquire knowledge that has a theoretical aspect and has not yet become a tangible executive output. In this context, interviewees cited issues such as creating an article, creating a patent that has not yet been applied, theoretical knowledge that creates opportunities for the future, and generating creativity and ideas. “In my collaboration with an oil company on acquiring technical knowledge about Nano drilling mud, the company wanted to know what was going on in the new fields,” said a university professor who has worked with oil companies on collaborative projects. “For this reason, this knowledge did not result in the company’s product. In such cases, the research results will usually lead to product development later in a new project.” Another professor said about the dimension of creativity and ideas, “An intangible output of research collaboration projects is to create ideas and creativity so that companies can see things from another window.”

The second category of industry learning resulting from collaboration with universities (i.e., exploitative learning) is related to the cases in which the project output is used in the company’s activities. In this regard, experts point to issues including problem identification and solution, reverse engineering of a product, reducing product/process costs, increasing product/process quality, product/process innovation, improving equipment utilization knowledge, and improving the capacity of personnel during the project. “I have not sought to create an article in the few years I have been in this position,” said one project manager who

is the director of research and technology for a large petrochemical company. "Several articles may have been created sideways, but the goal of most projects has been to solve one or more problems in the industry." One of the professors said about the outcome of his project of collaboration with an oil company, "An executive example in which I collaborated was the designing and construction of underwater robots, in which we gained technical knowledge with the collaboration of the industry." The first and second categories of learning in the study of Bishop et al. (2011) are called explorative and exploitative learning, respectively, and the results of interviews with experts in the present study also confirm this classification.

Another issue addressed by the interviewees is the relationship between the type of explorative and exploitative learning and the type of industry and the level of development of the country in which the industry operates. One of the professors active in oil projects said about the relationship between the two types of learning and the type of industry,

Explorative learning usually takes place in collaborative projects in new and advanced fields such as nanotechnology and biotechnology, and projects carried out in industrial companies in the fields of oil, gas, and petrochemicals in Iran often follow exploitative learning. Of course, there are cases – for example about increasing oil extraction using nanoparticles – where the output of the project has been explorative learning.

Another professor said, "A university may work with the Royan Research Institute on stem cell research whose output is knowledge to create opportunities for the future, but in mature industries such as oil in Iran, the target is usually the applied output."

Most of the interviewees mentioned the relationship between the type of learning and the level of development of the country. One professor stated,

The industries of developing countries, which are mostly followers of other industries, are often involved in current issues, and their projects with universities, they often do not seek to reach new frontiers of knowledge and pursue problem-solving, reverse engineering a product, reducing costs, or improving quality.

A petrochemical project manager said, "When our technology dates back to 15 years ago, the organization in projects does not look for knowledge-edge technology, and [rather] it seeks to use the most efficient solution."

4.2. Factors Affecting Learning

To identify the factors affecting the learning of industrial companies in research collaboration projects with universities, 6 themes and 25 sub-themes were identified, each of which is described below. The results of the analysis using MAXQDA software for themes and sub-themes for factors affecting the learning of industrial companies in research collaboration projects with universities are given in Table 5. The results of the theoretical saturation measurement for the factors affecting learning are given in Table 6. As can be seen, the number of newly identified codes has reached zero since interview 13.

4.2.1. University Features

One of the characteristics of the university that has been introduced by experts as a crucial factor in the learning of industrial companies in collaboration projects is the business model of the university. About this issue, which is a common concern in developing countries, some interviewees point to the university's excessive dependence on public funds. For example, one of the university professors who has been involved in many collaboration projects in the oil industry stated, "When the business model of our universities is based on the general government budget, they have no incentive to work to promote industry learning, because

they are not going to make money that way."

A group of experts points to the mechanism of collaboration control by the university. Some of them have introduced the university's involvement in the project definition process as affecting learning. The director of research and technology of a large petrochemical company said, "There is no sensitivity on the part of the university that the defined subject is within the power of the professor and [he/she] accesses results." Others point to oversight of funding allocations. For example, one university professor said, "University control over the allocation of financial and human resources is very important." Some interviewees also cite the monitoring of the quality of collaboration projects by the university as an effective factor in learning. "Usually, the university itself has no quality control over the performance of the executor," said the head of the research and technology department of one company.

Another issue that has been addressed in the interviews is university rules and procedures. Some of them have mentioned incentive laws. "To motivate professors, the mechanisms for promoting them should be based on the amount of knowledge transfer to the industry," said a university professor. Some experts point to the mechanism of nurturing students needed by the industry. "Students' participation in the industry during their studies turns them into intermediate links between industry and university after graduation," said one university professor.

Experts also point to the university's capacity as an influential factor in learning. For example, one of the university professors said, "Working with old equipment and lack of laboratory materials weakens the executive capabilities of academics."

The university brand has also been identified as influential in the statements of some experts. However, it is noteworthy that despite the fact that this factor has been identified as an important factor in many studies, its importance was not emphasized in this study.

Table 5. Frequency of Themes and Sub-Themes for Factors Affecting the Learning of Industrial Companies in Research Collaboration Projects With Universities

Subject	Frequency	Themes	Frequency	Sub-themes	Frequency
Factors affecting learning	188	University features	38	University capacity	5
				University brand	4
				Collaboration control mechanism by the university	12
				University business model	8
				University rules and procedures	9
		Industry features	26	Knowledge management	6
				Industry collaboration control mechanism	11
				Mechanism of evaluation and selection of university contractor by industry	5
				Senior management commitment	4
		Collaboration environment features	31	Government rules and procedures	10
				Collaboration control mechanism by the government	10
				Government support for the research	5
				Competitive organization environment	4
				Integration between institutions influencing the project	2
		Industry and university communication features	32	Trust between industry and academia	13
				Degree of the partnership between the parties	10
				The communication structure of industry and university	4
				Homogeneity of the goals and procedures of the parties	5
		Content features	29	Fitness of the content with the industry features	16
				Fitness of the content with the university features	6
				The level of novelty and tacit knowledge	3
				A precise definition of the problem	4
		Collaboration team members' features	32	The abilities of the university team leader	23
				Motivation and adaptation of members	6
				Influence of the industry team leader in his company	3

Table 6. The Results of the Theoretical Saturation Measurement for Factors Affecting the Learning

	Interviews														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
University capacity	×		×			×					×		×		
University brand							×		×		×			×	
Collaboration control mechanism by the university	×	×	×		×	×	×	×		×		×	×		×
University business model		×		×	×	×		×				×	×		
University rules and procedures			×			×	×	×	×	×	×			×	×
Knowledge management	×		×			×						×	×		×
Industry collaboration control mechanism		×	×		×	×	×	×	×		×		×	×	
Mechanism of evaluation and selection of contractor								×		×		×		×	×
Senior management commitment				×	×							×		×	
Government rules and procedures	×	×		×	×	×	×	×		×	×	×		×	
Collaboration control mechanism by the government		×	×	×		×	×		×		×	×	×	×	
Government support for the research	×			×			×			×					
Competitive organization environment				×					×		×			×	
Integration between institutions												×			×
Trust between industry and academia	×	×		×	×		×	×	×	×	×		×	×	×
Degree of the partnership between the parties		×		×	×	×	×		×		×	×			×
The communication structure of industry and university	×		×			×				×					
Homogeneity of the goals and procedures of the parties		×					×		×	×				×	
Fitness of the content with the industry features	×	×		×	×	×		×	×	×	×	×	×	×	
Fitness of the content with the university features					×			×		×		×		×	×
The level of novelty and tacit knowledge											×	×		×	
A precise definition of the problem									×			×		×	×
The abilities of the university team leader	×	×	×	×	×	×	×	×		×	×	×	×	×	×
Motivation and adaptation of members	×		×				×		×			×			×
Influence of the industry team leader in his company						×				×	×				
New codes in each interview	10	5	1	2	1	1	1	1	1	0	1	1	0	0	0

4.2.2. Industry Features

Some factors from the industry also affect learning in the collaboration between industry and academia. One of these is the mechanism for controlling collaboration by industry. According to experts, if there is no proper control by the industry in defining, segmenting, sourcing, and reviewing the results, the desired learning will not be achieved from the project. One of the university professors said, "Because many projects are multidisciplinary, the industry must segment them under its control and delegate them to distinct groups." The same university professor said about the controls that must be exercised during the project process to achieve learning, "If the performance of the project is poor, why shouldn't we protest to the university?"

Another issue that experts have pointed out is the mechanism for evaluating and selecting a university contractor by industry. "If the industry gave the project to the professor based on the evaluation of his records, he would be forced to commit, because if his performance is poor, he knows that he will miss the next projects," said a university professor involved in oil projects.

Another issue is the knowledge management of companies. This is due to both the knowledge management structures in the company and its culture. The head of research and technology at a refinery said, "There has to be an atmosphere of trust in which knowledge circulates between the same people who need to learn." One university professor said, "Sometimes a person who is on the border of the company knows a lot because of the relationship with the university professor, but one layer after him does not know anything."

Senior management commitment is another factor that has been evaluated by experts as effective. "Research can take years to conclude," said a research project manager in the petrochemical industry, who continued, "So, there must be managers who accept these costs."

4.2.3. Collaboration Environment Features

The collaboration environment includes other institutions, actors, and stakeholders that are outside the industry and academia, but affect their collaboration. One of these features is government laws and procedures. Many interviewees consider the faculty promotion mechanism as an incentive to transfer knowledge to industry. “If the indicator (instead of the article) is how many spin-offs were created by the professor and how many industry problems he has solved, the industry learning is important for the professor,” said one professor.

Another factor that is considered effective in the learning of industrial companies is the mechanism of government control over collaboration projects. One of these is the government’s mechanism for controlling student dissertations. “The government should have control over the topics of public university dissertations to address industry issues,” said one professor who is also active in the government.

Another factor is government support. Some interviewees believe that collaborative learning works best in an environment with the right infrastructure and market, and that this is the government’s job. “The government should provide laboratory infrastructure for collaboration,” said one gas project manager.

Another factor in this category is the organization’s competitive environment. “Having serious competitors encourages companies to avoid learning lag,” said one professor.

In addition, integration between different institutions influencing the project is one of the effective factors in this field. “During the project, so many different stakeholders had different expectations that it was not possible to satisfy all those expectations and goals together, and eventually the project goal completely deviated,” said one professor.

4.2.4. Industry-University Communication Features

These characteristics are things that do not refer solely to one of the parties in the collaboration between industry and academia, but rather are related to how they are connected. One of these is the degree of partnership between university and industry. A noteworthy point in this regard is the difference in the views of the interviewees to the positive or negative effect of the degree of partnership on collaborative learning. Some of them evaluated it positively, “I think that the more the interaction between the university and industry increases, the more the industry learns during the process and at the output.” Others suggested that it damages collaborative performance. For example, one of the university professors said, “Due to the conflicts that occur, I do not have valuable experiences about many interactions during the project.” Others consider its positive effect to be conditional on another factor, such as the tutor’s managerial ability, the existence of a common language between the parties, and the definition of the learning frontier. “If there is a conflict management capability in the university team leader, I would prefer more cohesive teams between industry and academia,” said one industry expert.

One of the factors cited by many experts is the trust between industry and academia. One of the experts stated, “Trust has two aspects. One is to trust that person’s commitment, and the other is to trust his or her abilities.” Others point to the university’s reliance on industry. “During the project, subjects were added that were not in the contract. This makes them distrustful,” said one professor.

Another issue in this category is the communication structure of industry and academia. This structure means a context that facilitates the interaction of the parties. “Unfortunately, the industry-university liaison offices do not know anything about the projects,” said one expert.

The homogeneity of goals and procedures between academia and industry is also considered effective in learning. “The university claims to be moving on the frontier of

knowledge, [while] the industry believes that it works with old technology and does not need advanced knowledge," said a project manager in the petrochemical sector.

4.2.5. Collaboration Content Features

Some interviews address various aspects of the relevance of the content to the characteristics of the industry. These include compliance with the mission, competitive advantage, and level of development and real needs of the industry; similarities with previous industry activities; and the existence of similar projects with the content of collaboration in the industry. "The subject of the project should not be too different from what the industry is working on," said one interviewee. One professor stated, "The project should be defined based on the needs of the industry, not on the compulsion of the parent organization."

The content of the collaboration should be commensurate with the characteristics of the university. It includes the relevance of the content to how it is done in university and its relevance to the university level. Regarding the first issue, one of the university professors said, "If the project is to develop technical knowledge, it should be done with the structure of the dissertation. But if, for example, the project is to build a real robot, it should be done through a collaborative project." Regarding the second issue, one of the university professors said, "For example, the University of Tehran is more suitable for higher technology projects as it moves on the edge of knowledge, while local universities are more suitable for solving the routine problems of industry."

The degree of novelty and tacit knowledge is also introduced in some interviews as an influential factor. "The more implicit the knowledge that is worked on, the less the industry learning," said one project manager at an oil company.

Another dimension of this category is the precise definition of the subject of collaboration. "When the issue is not precisely defined, each party has its perception of the issue," said one expert.

4.2.6. Collaboration Team Members' Features

Instead of focusing on organizational levels, this feature addresses the role of collaborative team members in both industry and academia at the micro-level. In general, these are the characteristics of the university team leader, the industry team leader, and other members of the collaboration team. Concerning the university team leader, these characteristics include scientific ability, communication ability, previous experiences, and commitment. "University and industry live in two different mental worlds," said one university professor, who continued "the art of a university professor is to create a common language between the parties."

Characteristics related to the members of the collaboration team include motivation, the spirit of collaboration, experience and ability, complementarity, and focus on the project. "Unfortunately, in some cases, team members are too busy in their company, and this affects their focus on the project," said one interviewee. "In interdisciplinary projects, the lack of proper cooperation of different professors harms learning," said one professor.

Regarding the characteristics of the industry team leader, one of the project managers in the gas sector said, "The power of the industry team leader is important in encouraging industry people to collaborate."

In summary, the research findings related to the learning dimensions of industrial companies in research collaboration projects with universities and the factors affecting them can be seen in the model presented in Figure 1. In this model, learning from university-industry collaboration includes exploitative learning and explorative learning, and the factors affecting it include university features, industry features, industry-university communication features, collaboration environment features, collaboration content features, and collaboration team members' features.

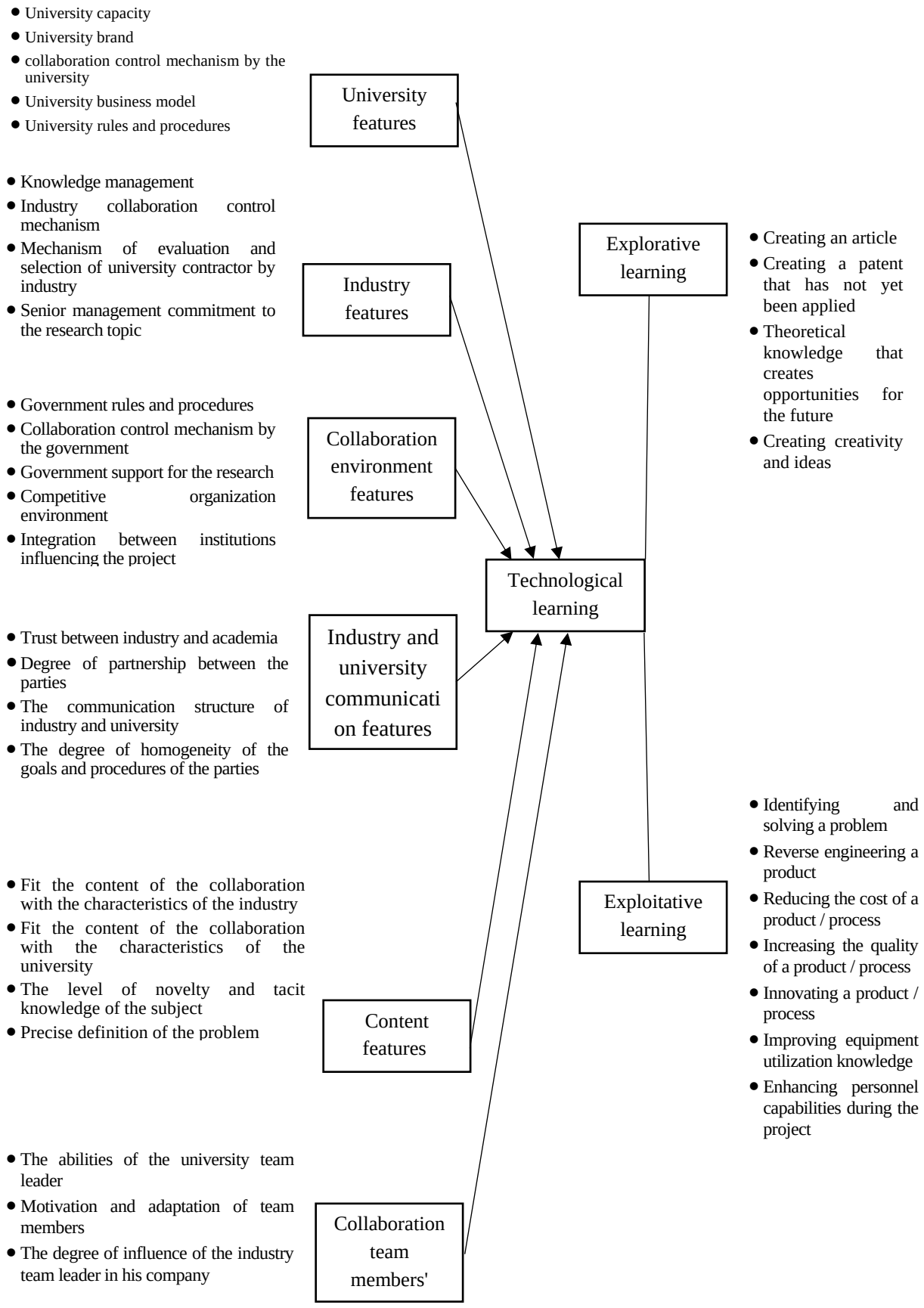

Figure1. Learning Dimensions and factor affecting them in U-I collaborations

5. Discussion and Conclusion

This study sought to answer two questions. First, what factors affect the learning of companies in research collaboration projects with universities in developing countries? Second, what do industries in these countries learn in these collaborations? It was also examined whether there are specific categories for these learning cases and whether these specific categories of learning are related to the type of industry and the level of development of the country.

For this purpose, after reviewing previous research, to answer the above questions, qualitative data resulting from in-depth and semi-structured interviews with experts in this field were collected and analyzed. In this regard, fifteen experts in three sectors of industry, university, and government related to nine industry-university research projects in the field of oil, gas, and petrochemicals were interviewed. After coding, the research findings were classified and analyzed into two groups, namely sub-themes and themes. Finally, in response to the research questions, a comprehensive model including the dimensions of learning and the factors affecting it was presented (Figure 1).

In response to the first question, 25 factors (sub-themes) affecting the learning of Iranian oil, gas, and petrochemical companies in research collaborations with universities were identified. These factors formed six themes including university features, industry features, industry-university communication features, collaboration environment features, collaboration content features, and collaboration team members' features. Some of the factors that were emphasized more than others were university business model, collaboration control mechanisms, rules and procedures, degree of partnership between the parties, fitness of the content of the collaboration with the industry features, trust between the parties, and competence of the university team leader.

Of the seven crucial factors mentioned above, four factors including the degree of partnership between the parties, fitness of the content of the collaboration with the industry features, trust between the parties, and the competence of the university team leader have also been suggested in previous research (mostly in research done in developed countries). However, it seems that three remaining factors – i.e., the university business model, collaboration control mechanisms, and rules and procedures – have not been mentioned in previous studies and result from the context of developing countries.

Regarding the level of interaction between the parties, Cyert and Goodman (1997) stated that a team made of several industry personnel and several academics covers some cultural distances between the parties and creates a shared understanding of technical features between industry and academia. In addition, Bruneel et al. (2010) suggested that the diversity of communication channels in university-industry collaboration has a positive effect on the performance of collaboration by reducing orientation barriers. The present study confirms the findings of these studies. Industry-university collaboration projects may have various levels of involvement between industry and academia, depending on the type of collaboration. For example, methods such as joint research and development and networking have a higher level of a partnership than the research contract method. The findings of this study showed that if there are some conditions – e.g., the tutor's ability to manage conflicts, the existence of a common language between the parties, and a clear learning frontier at the beginning of the project – more interactions will lead to more learning for the industry.

Dooley and Kirk (2007) emphasized the relevance of the content of collaboration to industry characteristics and said that to succeed in university-industry collaboration, the organization must be familiar with the subject and should consider it as one of its priorities. Sherwood and Covin (2008) also considered the relevance of the subject to the core

competence of the company in learning important. Our research findings also showed that the degree of content compatibility with the mission, competitive advantage, level of development, and the real need of the industrial company are remarkably effective on the resulting learning. In addition, learning is enhanced if the topic of collaboration is like previous industry activities or similar projects are underway with the topic of collaboration in the industry.

Trust between the parties has also been introduced in many studies as an antecedent of industry learning in collaboration (Barbolla & Corrdera, 2009; Bellini et al., 2018; Oliver et al., 2019). In this study, trust was introduced as a principal factor in learning. In this case, the experts referred to the industry's trust in the university and vice versa, and introduced it in two aspects, i.e., trust in the other party's commitment and trust in its capabilities.

Ting et al. (2018) explored the competency of the professor (comprised of market knowledge, self-leadership, and social capital), and its positive effect on collaboration was confirmed. In addition, in the present study, the positive effect of the competence of the university team leader was emphasized greatly. Accordingly, he/she must not only have the scientific ability but also need to be able to turn scientific concepts into industrial applications through his/her previous executive experiences. In addition, communication skills, project management skills, and behavioral knowledge of the university team leader are required for collaboration to lead to learning.

One of the three factors that seem to have been ignored in previous research as a factor affecting learning is the university business model. One of the institutional features of Iran is the government's high involvement in various fields. The university is no exception to this rule. Excessive dependence of Iranian universities on public budgets has weakened their motivation to work effectively with industry and has affected industry learning from universities.

Another factor is the control mechanisms of collaboration by all three sections of academia, industry, and government. These controls include defining, financing, and monitoring project results. In the university sector, effective control from the beginning to the end of the collaboration is particularly important. In the industrial sector, proper controls over the selection of professors, project definition, financing, and monitoring of results are also considered important. The government controls over the titles and results of dissertations in the industry are also important.

Government and university rules and procedures are other factors that do not seem to have been addressed in previous research. In this regard, instead of emphasizing the article publication, faculty promotion mechanisms should focus on solving industry problems and educating industry actors. The university should also consider procedures for closer ties with industry. Students who are trained based on the specialties required by the industry and work on joint projects with the industry understand the language of both parties after employment. They can be excellent communication links for the learning of industrial companies in collaboration projects with the universities.

In response to the second question, eleven dimensions (sub-themes) were identified. These dimensions formed two themes, namely explorative learning and exploitative learning. In the present study, experts introduced industry learning resulting from collaboration projects with the university in two broad categories. In the first category, the output of the project is the knowledge that has a theoretical state and has not yet been applied to the industry. With regard to this group, experts mentioned things like creating an article, creating a patent that has not yet been applied, theoretical knowledge that creates opportunities for the future, and creating creativity and ideas. In the second category, the output of the project is used in industry activities. These include identifying and solving a problem, reverse engineering a

product, reducing the cost of a product/process, increasing the quality of a product/process, innovating a product/process, improving equipment utilization knowledge, and enhancing personnel capabilities during the project. This finding confirms the category mentioned in Bishop's research (2011).

The results showed that companies in developing countries usually pursue exploitative learning in collaboration projects with universities. In these countries, mature industries active in older technologies such as oil, gas, and petrochemicals typically pursue exploitative learning, and explorative learning is often the result of universities' collaboration with new technology-based firms such as those working in the field of nanotechnology and biotechnology. This consequence can be interpreted as the fact that most mature companies in developing countries, due to the lack of technical knowledge, seek problem-solving and improving the existing situation in collaboration projects rather than expanding the frontiers of knowledge.

6. Implications

The findings of the present study might bring about theoretical implications and practical implications, as follows.

Regarding theoretical implications, a model was presented in this study that includes the factors affecting the learning of companies in research collaboration with universities and the dimensions of learning in this collaboration in a developing country. This study also provided a comparison between the factors affecting learning in the mentioned collaborations in developing countries and developed countries. In addition, our study showed that industrial companies in developing countries are more interested in exploitative learning in collaboration with universities. Of course, explorative learning is pursued in new technology-based firms.

Regarding practical implications, the research findings can help three groups. The first group is industry managers. There may be many issues for collaborating with universities. However, when choosing a collaborative topic, managers should keep in mind that if they are looking for high levels of learning in the project, the topic needs to be compatible with the company's mission, real needs, previous projects, and core competencies. After determining the topic, it is very important to control the collaboration step by step during the selection of the professor, allocating resources to the project, and achieving the results. Forming joint teams with the university and moving towards collaborative methods that require more interaction between the parties will lead to more learning for the industry if the necessary controls are in place. Companies should also follow trust-building practices throughout the project.

The second group is academics. Universities need to get rid of over-reliance on government budgets. The percentage of universities earning from industry collaboration projects should be increased to create the necessary incentive to transfer knowledge to the industry. In addition, the university's control over the performance of project teams in terms of topic definition, payments, allocation of people and project outcomes should be increased. Otherwise, the performance of the project will become too dependent on the competence of the university professors. On the other hand, professors involved in projects should focus on improving management skills such as project management, organizational behavior management, and communication skills.

The third group is policymakers. Based on the results of this research, policymakers are advised to modify the promotion rules of professors. Instead of focusing too much on scientific outputs such as articles, they might shift to practical outputs such as solving industry problems.

Procedures for enrolling graduate students in public universities also need to change. These students must be recruited based on a specific national or industrial problem, and the results of their dissertations must be controlled by the government in appropriate ways.

7. Limitations and Suggestions for Future Research

This research had several limitations. Due to lack of access, in three of the nine projects reviewed, it was not possible to interview the university team leader. However, interviews with people from both sides in the other six projects appear to have covered a potential gap. The second limitation goes back to the nature of qualitative research based on a few cases. Due to the small number of samples in these studies, caution should be exercised in generalizing the results to the whole community. To solve this limitation, mixed methods have been developed. In addition, the present study has been conducted in Iran's oil, gas, and petrochemical industry, and caution should be exercised in extending it to other industries and other developing countries.

To increase the generalizability of the results, the future researchers are recommended that the model obtained in this research be evaluated in quantitative research with larger samples. In addition, it is suggested to compare the effectiveness of the factors mentioned in this study in different sectors of the industry. It is also suggested that the role of industry-university participation (project type) on learning in industry-university collaboration be examined in more detail and use moderators including the managerial ability of the university professor, the existence of a common language between the parties, and the level of the definition of the learning frontier.

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