Factors affecting technological learning through collaborations in developing countries: case study from the oil and gas sector

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Abstract: Technological learning is one of the most important functions of technological collaboration in developing countries, and the success of collaborations also depends on it. In the current qualitative study using a case study approach, an attempt has been done to determine the dimensions of technological learning in the foreign investment contracts of the oil industry. Data analysis was performed using theme analysis method and a qualitative research model was designed. According to the findings of this study, the technological learning framework has several main categories, namely: 1) contract features; 2) infrastructural aspects; 3) characteristics of technology receiver; 4) characteristics of the foreign partner; 5) the nature of knowledge.

Keywords: technology transfer; energy; technological capability; technological learning; technological collaboration; foreign investment contract; oil and gas sector; developing countries; Iran.

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1 Introduction

Technological collaboration contracts have transformed from conflict between foreign companies' interest and national ones to participation in the division of profits or the proportional allotment of profits (Iranpour and Crembelly, 2006). On the other hand, acquiring knowledge through collaboration helps organisations offset their resource constraints (Zahra and George, 1999), and let them use their core competencies better to gain the competitive advantage (Figueiredo and Piana, 2020). In developing countries, firms typically have low technological capacity and capability, while low productivity and inability to develop new technologies or improve existing ones are among the reasons for the underdevelopment of such nations. That is why identifying frameworks and procedures that lead to the adaptation, improvement and development of technology is a key issue in developing countries (Nozari et al., 2020).

According to Viotti (2002), in order to increase the absorption capacity and thus improve the effectiveness of the knowledge and technology transfer process, it is necessary to shift the learning process in firms and organisations from passive to active learning. Also, as sciences progresses and technological processes become more complex, companies can no longer produce and deliver innovative products and services independently, rendering the need for collaboration and sharing of knowledge and abilities to achieve this advantage undeniable. For example the Norwegian Oil Industry reflects a successful experience where importance and attention to learning in technological collaborations is quite tangible. In 1997, the Norwegian Ministry of Oil and Energy in collaboration with other Norwegian industries established the Oil and Gas Company Association with over 100 companies active in the oil and gas sector with the aim of strengthening the presence of Norwegian oil and gas companies in global markets. The union covers the entire supply chain of the Norwegian oil and gas industry, and by taking advantage of the extensive and close ties with its member companies, has been able to provide the necessary platforms to boost mutual collaboration between oil and gas firms as well as technology and service suppliers and government agencies. Among other services the association has provided to its member companies, is helping these firms to attract international opportunities and projects in the oil and gas industry, while increasing their global competitiveness and developing their international relations with government agencies at home and abroad, and provide information on oil and gas industry innovations and cost reduction strategies.

The infrastructure in the developing country has a decisive effect on how the receiver learns in the collaboration. Infrastructure means the support system, coordination and follow-up that is found in government departments, companies and other organisations that are involved in technology transfer process (Chatterji, 1990). In developing countries such as Iran in order to attract international firms and to enhance their scientific and technological potential, science and technology policymakers formulate various laws, regulations, policies and strategies and try to direct the current of development inward of

the national borders. Path of capability evolution in Iranian firms is shaped by a gradual movement towards acquiring capabilities (Ahmady and Mehralian, 2020). On the other hand, due to its strategic importance in the region, the oil and gas industry has always sought to access the latest global technologies and developments. For this reason, vast effort has been put into signing contracts with large and capable foreign companies to import and localise their technology. Success of international renowned companies is based on their technical and engineering capabilities and strong technological infrastructure where industrial competence is the source for most of their revenues. But oil trade in oil-rich developing countries, such as Iran, is based on oil sales and relying on large oil companies and foreign technology suppliers to meet their most immediate industrial needs, especially at the design, engineering, and machinery levels (Nozari et al., 2020). However, despite the importance of learning technology in collaboration, the process remains unknown. In addition, our theoretical and practical understanding of what learning is and how it can play a role in the development of organisational capabilities is very inadequate, because learning is a dynamic and invisible process whose results are often intertwined with other organisational activities (Garoosi Mokhtarzadeh and Faghei, 2019).

Despite previous research in the field of technological learning in developing countries, a comprehensive model has not yet been presented. This study provides a comprehensive model consisting of a network of topics related to technology learning and their classification in the form of key components affecting technological learning. The aim is to increase the capacity of developing countries to use more of their potential in collaboration. For this purpose two important contracts – the Development Project of North Azadegan Field and the Development Project of Darkhovein Field – in Iran are studied as case studies. The importance of the North Azadegan Project is that it is one of the joint oil fields situated west of Karun River between Iran and Iraq with a significant contribution to increasing Iran's oil production capacity. The purpose of this development project is to produce, process and transport 75,000 barrels of crude oil and 39 million cubic feet of gas per day by drilling 58 wells during the first phase, as contracted to China National Petroleum Corporation (CNPC).[1] Darkhovein Oil Field is located 30 km north of Khorramshahr and 100 km southwest of Ahvaz in Iran (Ahmady and Mehralian, 2020). The goal of this project is to produce 160,000 barrels of light crude oil per day in two phases; producing 50,000 barrels per day in the first phase and 110,000 barrels per day in the second. The main contractor of this project is Eni[2], an Italian multinational oil and gas company.

Following interviews with key people and senior managers of Iran's oil industry, the researcher has been given access to reliable sources, which means the research data is valid and can be cited. In this study, after extracting the network of technological learning themes, the researcher has analysed the status of each case according to the interviews. Finally, it was concluded that technological learning in oil contracts, in addition to the provisions of the contract, is highly dependent on other factors such as the country's infrastructure, socio-cultural factors and the technology learner's motivation. Therefore, and based on the issues raised, the research question is: What is the technological learning framework in the foreign investment contracts of the oil industry in developing countries?

2 Literature review and research background

2.1 Technological collaboration

Technological collaboration is a process in which the parties work together to achieve a common goal, work together and share experiences, knowledge, skills and technology. In recent decades, the formation and establishment of strategic partnerships has gone through significant growth. The biggest change that will affect all businesses is the creation and growth of partnership – not ownership – based relationships between organisations (Inkpen, 1998).

In many cases, it shapes the goals of organisations to form such collaborations. These goals and incentives include risk reduction, sharing technology development costs, access to scale-driven economic considerations, sharing specific knowledge, information and resources needed to develop technology, accessing new markets, accelerating the process of globalisation, and accelerating the process of technology development, as well as its commercialisation, setting standards, learning and acquiring knowledge (Trott, 2008).

Collaboration provides an opportunity for firms to increase and strengthen their strengths with the help of partners. Gathering firms with different skills and knowledge bases under collaboration provides unique learning opportunities for partner firms. Differences in partners' skills and knowledge accelerate learning among co-workers. In fact, partnerships open the door for firms to their partners' capabilities, the continuation of which requires the sharing of firm resources, including resources of knowledge and technology (Inkpen, 1998). Collaborations and related overflows need customised policy frameworks and a long-term outlook on local capacities, without which the host country could face risks in laying scientific grounds in national networks or becoming dependent on foreign partners (Guridi and Pertuze, 2019).

Technological collaborations come in many forms, each of which can be compared in a variety of aspects. One of the methods of technological collaborations is investment contracts, the types of which in the oil industry are described below. Learning is one of the most important functions of technological collaboration, on which the success of collaborations is highly contingent. Consequently, establishing partnerships as one of the best ways to transfer knowledge between organisations can significantly improve the performance of partner enterprises (Inkpen and Crossan, 1995).

2.2 Technological learning

There is ample and growing evidence that intangible resources such as knowledge, know-how and social capital will prove to be the coal, oil, and diamonds of the 21st century for developed, developing, and emerging economies alike. (Carayannis et al. (2006) consider technological learning as a dynamic concept that helps individuals and companies perform tasks faster and better, and identify new opportunities. In fact, technological learning is a method or tool to facilitate knowledge, technology management and dissemination. Kim also identifies universities, research institutes, other companies, and support systems as internal resources and available equipment, implicit human resources, documentary information, and foreign suppliers and buyers as national sources of technological learning in developing industrialised countries. It is proved that technological learning routines are regular and expectable behavioural framework conducted by multiple actors during the technological learning process (Guo et al., 2020).

Teece et al. (1997) describe learning as "a process by which repetition and experimentation enable tasks to be performed better and quicker and new production opportunities to be identified." They focus on the nature of individual and organisational learning, noting learning processes are inherently social phenomena. Learning occurs not only through imitation of individuals, as in the teacher-student, or teacher-trainee relationships, but also through participation in understanding complex problems. Learning requires common codes of communication and coordinated search procedures (Carayannis et al., 2006). So technological learning is the process by which a technology-based company creates, and upgrades its latent capabilities based on its explicit and implicit resource inventory. Learning combines technical and administrative processes (Jelinek, 1979). Companies use technology learning strategies as a response to changing windows of opportunities (Figueiredo and Piana, 2020). Despite the differences in the details of the subject, technological learning refers to the process of acquiring technological knowledge. In other words, technological learning is defined as the way in which an individual, company or country updates its knowledge of technology, products and processes and can develop and improve its performance using the extensive skills acquired (Hooshangi et al., 2013). Two main elements, namely technology absorption and incremental innovation, must be considered in defining the concept of technological learning at the enterprise level. The process of technology acquisition is successful when it has led to the development of technological capabilities of the firm (Hansen and Ockwell, 2014). Roper introduces technological learning as an interactive and continuous process of combining existing information and knowledge with new knowledge (Roper and Love, 2018).

By definition, the process of enhancing technological capability through the acquisition of external knowledge is called technological learning. Companies in developing countries considered as newcomers need a learning strategy to develop and achieve synergy, for reasons such as distance from technology and research and development (R&D) resources and distance from major markets (Hobday, 1995). This strategy demonstrates their ability to deal with threats and opportunities created in a competitive environment (Xie and Li-Hua, 2008).

Technological learning has been introduced in many studies as a cumulative, costly, conscious and purposeful process that is not automatic and inactive (Bell and Figueiredo, 2012). Viotti (2002) defines learning as a process of technical change that takes place through gradual absorption and innovation. In other words, learning is the absorption of existing techniques and methods. This means absorbing the already produced innovations and improving the acquired techniques and methods. Technological learning is an endogenous way to build technological capabilities in developing countries, which indicates the organisation's ability to use technology effectively, absorb and adapt external technologies and create new technologies over time, along with responding to environmental changes (Kim, 1999).

Table 1 Theoretical framework of technological learning literature

	Researcher	*Year*	*Subject*	*Learning process*	*Nature of knowledge*	*Collaboration platform*	*Characteristics of technology receiver*
1	Figueiredo and Piana	2020	Technological learning strategies and technology upgrading intensity in the mining industry: evidence from Brazil	✓			
2	Guo et al.	2020	How does the ambidexterity of technological learning routine affect firm innovation performance within industrial clusters? The moderating effects of knowledge attributes	✓			
3	Guridi and Pertuze	2019	Natural laboratories as policy instruments for technological learning and institutional capacity building: the case of Chile's astronomy cluster	✓		✓	
4	Roper and Love	2018	Knowledge context, learning and innovation: an integrating framework	✓			
5	Mirimoghadam and Ghazinoory	2017	An institutional analysis of technological learning in Iran's oil and gas industry: case study of south Pars gas field development	✓	✓	✓	
6	Carayannis et al.	2006	Technological learning for entrepreneurial development (TL4ED) in the knowledge economy (KE): Case studies and lessons learned		✓		
7	Lundvall and Lorenz	2007	National innovation systems – analytical concept and development tools		✓		
8	Reed et al.	2010	What is social learning? Ecology and society	✓			
9	He and Mu	2012	How Chinese firms learn technology from transnational corporations: a comparison of the telecommunication and automobile industries				✓
10	Araújo and Salerno	2015	Technological strategies and learning-by-exporting: the case of Brazilian manufacturing firms, 2006–2008				✓
11	Hu et al.	2014	The influence of knowledge source and ambidexterity in the thin film transistor and liquid crystal display industry: evidence from Japan, Korea, and Taiwan			✓	
12	Lundvall and Lorenz	2010	Social investment in the globalising learning economy	✓			

The higher the speed of technological learning in an organisation is, the faster the organisation acquires its technological capabilities. Therefore, it can be said that technological learning is the process of integrating technological capabilities into the organisation's system (Kim, 1999). Technological learning is defined in different ways in science and economics management (Xie, 2004). It can be concluded that despite the differences in details, there seems to be a wide acceptance among the authors that this concept helps the process of acquiring technological knowledge.

2.3 Technological learning in collaboration

Many reasons make organisations form collaborations. One of the most important factors justifying collaborations by organisations is learning, transferring and acquiring knowledge. Collaborations create a platform for organisational learning by organisations and allow firms to access the knowledge of other collaborating partners. Firms learn and acquire knowledge from other partners through collaboration activities and tasks, interdependence, solving the problem together, and observation of collaborative activities and achievements (Trott, 2008). Collaborations provide an opportunity for firms to increases and strengthen its capabilities with the help of partner. Collaboration, in which firms have different skills and knowledge, provides unique learning opportunities for both partners. Differences in skills and knowledge of partners accelerate learning; In fact, collaborations let firms know about the partner's capabilities, and the continuation of this requires the sharing of firm resources, including knowledge and technology resources (Inkpen, 1998).

In short, learning is one of the most important functions of technological collaboration, on which the success of collaborations will depend. One of the most important issues in collaborative learning is the ability of organisations to acquire knowledge. It is very important to note that just creation of collaboration cannot lead to the learning and development of knowledge base. In order to benefit from learning in collaboration, firms must identify their effective factors to enhance learning and knowledge acquisition and strengthen and eliminate them.

2.4 Conceptual framework

The summary of literature and its thematic division based on different aspects of technological learning is provided in Table 1. This categorisation has been used to design the initial interview question. For example one of the questions was "What is the role of nature of knowledge in technological learning in collaborations?"

So far a number of researches have been done in the subject of this research, and the researchers of this study have studied a part of them due to the proximity to their research, and after analysing them, they have extracted the innovation of their study. A review of the literature and research shows there has been no research that specifically focuses on the different dimensions of technological learning and examines the challenges and capacities in it and suggests a comprehensive model of these factors. Some of these researches are as follow:

- Mirimoghaddam and Ghazinoory (2017) sought to identify the factors that affect the performance of technological learning in large socio-technical systems. They has drawn the process model of the learning event in the oil industry and identified the existing bottlenecks.
- Derakhshan and Taklif (2016) stated that relying on foreign investment with international oil companies is not a suitable way to transfer and develop technology in the oil industry, unless, the growth of basic knowledge and operational knowledge related to the country's oil industry has provided a suitable platform for technology absorption, and the active presence of regulators with the objectives of monitoring, managing and improving efficiency in the technology market has provided appropriate platform that can develop absorption capacities effectively.
- Ghandi and Cynthialin (2012) have presented the model of optimal production in Soroush and Nowruz coastal fields, which has been closed by Shell Company. In particular, he examined the actual behaviour of the National Iranian Oil Company and its behaviour under contract and compared it with the production specifications that are in accordance with the terms of the contract.
- Shiravi and Ebrahimi (2006) first introduced buyback contract for then examined the main features of the mechanism. Third, the use of buyback for exploration and development and the challenges associated with it has been explored.
- Ebrahimi and Shiroui Khouzani (2003) provides a real picture of collaborations in oil sector, distinguishing them from conventional contracts in industrial projects, service contracts, and joint production agreements.

3 Research method

Technological learning models in this regard have been done in developed countries, but considering the environmental differences in developing countries such as social, political, economic issues with developed countries, it can be said that the paradigm of this study is interpretive and according to this paradigm, research approach is quality approach and research strategy is multiple case study. Case study is a method that uses more and more information sources to systematically examine individuals, groups, organisations or events. Case studies are performed when the researcher needs to understand or explain a phenomenon (Wimmer and Dominic, 2005).

The tools of this study include interviewing experts and reviewing the documents of the project. The interviewees were selected from the experts present in the North Azadegan and Darkhovein projects at different organisational levels and senior managers of the Ministry of Oil during the project implementation. The initial set of interview questions was designed according to categorisation of concepts which was extracted from literature review. The tools employed for the present research include interviews with experts and reviewing the documents of the noted projects. In the first stage, the interviewees were selected from among the people present in the foreign investment projects of the oil industry at different organisational levels and the senior managers of the Ministry of Petroleum during the implementation of these projects. At this stage, an attempt has been made to design the initial set of interview questions based on the

knowledge and expertise of each interviewee in order to collect the largest and most relevant data needed from different sources and individuals. In the second stage, the interviewees are selected using opportunistic and snowball approaches. In opportunistic sampling, the researcher uses the opportunity created to gather information. A particular behaviour may occur in certain circumstances and the researcher will select the next interviewee circumstantially. Thematic background and secondary industry data were also used during the interviews to create a complementary model. These resources were useful for validating and supplementing the data collected in interviews and for providing coherent and reliable analysis.

Secondary data of this research have been obtained through various databases, brochures, technical, legal, contractual documents, policy and strategic documents, reports and evaluations, and written experiences and lessons learned. This data set has been extracted from the archive of projects, documented experiences and lessons learned. In the case study approach to conduct a comprehensive and credible research, different data sources (interviews, documents, observations, etc.) should be used (Yin, 2009).

Table 2 Overview of interview

Interviewee code	*Roles and responsibilities*
A1	Former Minister of Oil
A2	Former Director of Legal Affairs of the National Iranian Oil Company
A3	Managing Director of Petroleum Engineering and Development Company (Executor of the project)
A4	North Azadegan Field Development Project Manager
A5	Darkhovein Field Development Project Manager
A6	Director of Petroleum Industry Research Institute
A7	Member of the negotiating team and drafting the contract
A8	Deputy Managing Director for Development Affairs of Petroleum Engineering and Development Company (Executor of the project)
A9	Executor of North Azadegan Field development project
A10	North Azadegan Field Development Project Planning Manager
A11	DCC Director of North Azadegan Field Development Project at CNPCI
A12	JMC Contract Member
A13	Darkhovein Field Development Project Planning Manager
A14	Darkhovein Field Development Project Engineering Manager

A total of 14 interviews were conducted with senior managers of the Ministry of Petroleum and project experts who had a history of participating in the contract drafting as part of the negotiation team, and these interviews were conducted with open-ended and semi-structured questions. The interviewing process stopped when the researcher did not arrive at a new finding and reached theoretical saturation. Theoretical saturation is a judgment based on which the researcher decides that there is no need to collect more information to help define the characteristics of classes in the research. In fact, theoretical saturation deals with the repetition of data in qualitative studies. The initial questions asked in the interviews were designed based on the thematic background of the research and the current conditions of the experimental field of research. The researcher continued to collect and analyse the data until the theoretical basis was created; that is, when no new data emerged in relation to the classes or the links between them.

The validity of this research is based on Cresol's views, primarily due to the researcher's long-term involvement with the research environment of the Petroleum Engineering and Development Company as the case manager which allowed the researcher to provide detailed introduction of the research, expressing concepts and aspects of technological learning to staff and gaining trust, which was supported by relevant managers. Secondly, evidence was gathered from various sources including interviewees, information resources including firsthand contract documents and project papers. The researcher also ran the methods and interpretations by one of the esteemed experts in the field of technological learning. In addition, the hypotheses were corrected as the interviews progressed. Responder's comments on the findings and interpretations were also collected.

Regarding the reliability of the interviews, five of the seven procedures suggested by Creswell were conducted: detailed note-taking, full audio recording of meetings, transliteration of recorded statements, transliteration of hints, pauses and details that usually fit. The coding was also done by a person who was not on the research team.

The method of data analysis in this research is theme analysis. The theme analysis process begins when the analyst considers patterns of meaning and topics that have potential appeal. This analysis involves a continuous reversal between the data set and the encrypted summaries and the analysis of the data that is generated. Writing the analysis starts from the first step. In general, there is no unique way to commence theme analysis of the study. The six steps of theme analysis are getting to know the data, creating the initial codes, theme searching, reviewing the themes, defining and naming themes, and preparing the reports.

Data analysis was performed according to the mentioned procedure in four general steps and relying on the comparison process. Comparison is the basic principle of the analytic process in qualitative research (Corbin and Strauss, 2008). By relying on comparison, the researcher can do what is necessary to develop the theory, classify, codify, delete, and modify classes or combine them. Continuous comparison has a dynamic relationship with research sampling. Based on the collected data, the researcher decides what data to collect in the next step and who is in possession of such information. The new data is also compared to the previous data and the analysis progresses accordingly. Finally, the classes show the highest level of abstraction of concepts in this study that have been developed to theoretically explain technological learning. In this regard, an attempt was made to deduce characteristics and features that include different concepts and provide more details, so that they can then materialise. Thus, classes of concepts were formed.

4 Research findings

After the researcher got acquainted with the collected data and reviewed and analysed them, interviews underwent open coding. A total of 190 semantic units were extracted from the interviews. At this stage, an analysis of the data obtained from the interviews was performed. To start, conceptualisation was done at the first level. Then, in order to identify the concepts, the interview data was studied and examined. Data with the same

semantic load was coded with a common title and the concepts appropriate to each were assigned to them. Then, those characteristics that include various concepts and provide more detailed components of the concept were inferred and then materialised. In this way, classification of concepts was developed. Finally, 18 concepts were created under five categories in the first level, and 84 concepts were created in the second level. The main and sub-categories can be seen in Table 3.

4.1 Collaboration platform

According to the interviews conducted, mastering the art of negotiation and including certain demands in the contract, can be a great help in learning and transferring of technology. Mention of training courses in the provisions of the contract is key. Writing down the nature of technology is also crucial to better understanding what needs to be learned. Determining the budget for purchasing a patent, receiving a contract strategy from an external party, creating long-term interactions, trying to increase the external party's obligations and establishing the right to inspect the field of operations and requiring the foreign party to conduct part of studies in the host country are some of them, as the provisions of the contract will have a significant impact on learning and is one of the findings of this study. On the other hand, the culture of countries as one of the most important macro factors will have a significant impact on the behaviour and culture of individuals and companies in that country. For example, in countries where teamwork and communication are cultural practices, people are more willing and skilled to relate to others, and as a result of these interactions and a necessary factor in knowledge transfer, more knowledge will be carried on to the knowledge receiving firms. Conversely, individuals and companies in countries with a weaker team spirit and conservative behaviour, and less willingness and skill to communicate with others are hesitant or reluctant to share their knowledge and experience with others. As a result, the culture of the country will have a significant impact on their behavioural pattern.

4.2 Country infrastructure

The government and the policy-making institution will play an important role in advancing the technological goals of the implementing company in technological cooperation. Reforming the necessary structures and infrastructure, such as establishing large corporations and allocating sufficient funds for research and development, are among the most important tasks of the government. As one interviewee put it: "Our companies are looking to make a profit as quickly and cheaply as possible, and they are not accepting long-term costs like research and development costs." Establishing and developing international relations makes them a more and more suitable option as an external partner. For example, in the North Azadegan Project, there were limited options for selecting a contractor for Iran as the host country due to the US-imposed sanctions.

Table 3 Summary of data coding process

Dimension	*Second-order themes*	*Number of first-order codes*	*Relevant examples of interviewers quotes*
Collaboration platform	The nature of technology transfer	4	The longer the period of cooperation, interaction and meetings, the more we get acquainted with the organisational culture of the foreign contractor.
			They must consider learning
			Technology is useless if you generalise. It remains to be seen in what areas we lack. The first step is to feel the need. In concluding a contract, you should try to provide a platform for technology transfer
	Terms of the contract	12	Technology transfer is different from education. The contractor must commit to bringing the device here. Start and go. Must be committed to on-the-job training during the installation process. Not that someone who is an employer's looking around to find out what he or she is doing
	Indirect effects of the contract	3	Learning is more about the mechanism of cooperation than the contractual aspect.
			We need to know how much technical, decision-making and training learning is best done in which contract and which contract is actually a better platform.
Infrastructure	Culture and society	4	There is xenophobia and cultural conflicts and feelings of mistrust
	Terms and conditions	5	The country's bureaucracy, of course, is large, interrupting work and tiring the contractor.
	Governance	10	We have a dichotomy between the positions in the Ministry of Oil and the Oil Company
Technology receiver features	Structural requirements of the project	5	We need to have a trustee to assess our strengths and weaknesses
	Absorption capacity	2	The head of the research institute should increase the motivation of the researchers and technologists of the organisation and increase the commitment and let the people know that it is the policy of the officials. If the system is abandoned, people may lose motivation and not feel the need to learn.
			Iranian companies must have a research and development mechanism that can acquire knowledge
	Managerial features	3	When an Iranian company is close to a foreign company for several years, its organisational behaviour gradually changes, which can later form that system in the absence of a foreign company. This transformation takes time.
			Management must make people behavioural and psychological
			The structure of human resources, especially the management of Iranian companies and their ability to obtain technology, knowledge and training from foreign partners is very important.

Table 3 Summary of data coding process (continued)

Dimension	*Second-order themes*	*Number of first-order codes*	*Relevant examples of interviewers quotes*
	Manpower	3	When an Iranian company is close to a foreign company for several years, its organisational behaviour gradually changes, which can later form that system in the absence of a foreign company. This transformation takes time.
			An atmosphere must be created in which the Iranian force has self-confidence and the space is suitable for manpower
	Company structure	3	The structure of human resources and, above all, the management of the executing company and their ability to obtain technology, knowledge and training from foreign partners is very important.
Foreign Partner Features	Foreign country features	1	Cooperation with European countries has always taught us a lot
	Foreign enterprise features	2	The companies that the National Oil Company works with are weaker than themselves and do not have the goods to supply, and the motivation of the Iranian side decreases, and gradually the learning enthusiasm weakens and they become routine.
			On the other hand, if we could cooperate with a reputable foreign company that had a history related to this activity, while adding value to the field, increasing production and protecting national interests.
	Commitments in collaboration	3	I did not see a commitment to do so in the contractor. I was able to search, and with my prior knowledge I knew what they were doing, but they did not tell us anything. This is the same training we did with technology transfer. Technology was transferred but not trained. As an observer, if you do not have an explanation, you do not understand what to do
The nature of knowledge and technology	Axes of technological learning	4	We need to prioritise what we need to address. At E&P, we only have to go to the core technologies. The older the tank, the more complex it becomes. This is where we need help and technology.
	Technological learning goals	9	Steps of need recognition, technology knowledge, and which knowledge should be turned into technology.
			Transfer of technical knowledge in the field of development of oil fields, transfer of technical knowledge in the field of new technologies appropriate to drilling wells, transfer of technology in the field of exploitation of the field after development are among the learning objectives.
	Technological learning tools	5	Upgrading technical knowledge in human resources
			Transfer of up-to-date and advanced equipment and tools to the world
			Transfer of knowledge of integrated management of field development and operation
	Technological learning requirements	6	Holding training courses inside and outside the country
			Establishment of a technical team with a contractor team to learn on-the-job skills
			Hiring Iranian specialists and forces in its organisational chart

Therefore, despite the experience gained in the Darkhovein Project indicating that cooperation with European companies and companies with new technology leads to more learning, the opportunity was not presented for a second time. Another obstacle to technology transfer is the Ministry of Petroleum's sole focus on production and inattention to technology exchange. The policy-making body's due attention to technology transfer is definitely a significant factor for progress. Experts active in the North Azadegan Field Development Project stated, 'managers' efforts have only been to increase production and completion of the project in the allotted time, which is one of the reasons behind a lack of serious technological learning." Institutional and regional characteristics, macro-development policies, appropriate incentives and punishment systems, joint research and development with academic centres, empowering the private sector, localisation of successful policies and models, and promoting managers' view of technology transfer are among factors that play a role in technological learning governance as mentioned by the interviewees.

Another influential groundwork is the law and regulations governing the country and influencing the transfer of technology. The law on the use of domestic potential is among the Iranian laws that have a great impact on the transfer of technology. In the contract for the development of North Azadegan Field, the contractor has been asked to sign a condition of 'using domestic technical capacity'. According to this regulation, CNPC is obliged to use Iranian manpower or goods and services in the North Azadegan Project. The purpose of such conditions is to create jobs, develop technical capacity through learning, training and technology transfer. Benefits of using domestic technical capacity are mostly for investable countries; as such conditions are used in most of the world's oil contracts. The existence of legal barriers to knowledge transfer is also a major obstacle to technology transfer. Insufficient funding for research and development is another serious challenge. Laying tax-related punishment and incentive laws as well as industry policies can also help reform structures and improve technology transfer.

4.3 Technology receiver characteristics

Of the important things that boost technological learning are the skill and capability of the technology receiving workforce and creation of a suitable environment for learning and interaction with external co-workers. Absorption capacity is usually defined as a company's ability to use existing knowledge and information through interaction with other organisations (such as other firms, partners, knowledge providers, i.e. research institutions). "Papers and contracts do not oblige a party to carry anything over. We have a low absorption capacity and must focus on our inputs as recipients", said one senior executive.

One of the important factors affecting the technology aspect is the wide technological gaps coupled with large foreign market shares, which lay the tracks for the emergence of overflows. The amount of direct foreign investment overflows will increase the opportunities for domestic firms to achieve higher levels of efficiency versus imitating foreign technology (technological shortcut hypotheses). However, the gap should not be too wide and extensive that it prevents domestic firms from absorbing the technological benefits of multinational corporations, nor be so small that there is nothing to learn. For example, in the North Azadegan Project, where the foreign contractor, CNPC, did not have a large technological gap with Iranian companies, the amount of learning was much

lower than projects like Darkhovein, where an Italian company introduced a new technology.

A participatory environment in the project team prepares the ground for proper interaction with an external partner. Increasing the capability and motivation of human resources in order to improve the ability to acquire, adapt, convert and exploit technology are among the factors promoting learning in technological cooperation. Identifying missed opportunities in previous contracts, documenting past experiences, and using existing capabilities can lead to increased learning in the future. It is important to evaluate training courses with the same purpose. One of the major problems in learning is the lack of attention to research and development in the country. Allocating the right amount of funding to research and development can increase the ability to succeed in collaboration.

4.4 Foreign partner characteristics

The skill and ability of the foreign partner company and the type of relationship between the country in question and the country learning the technology are also among the defining points in promoting learning in cooperation. Pre-existence cooperation or history, financial capability of a foreign firm, ability of the firm in project management and cooperation with patent firms, all contributes to increasing the amount of learning in collaborations and lead to the acquisition of effective communication skills and knowledge by the learning firm. The longer the experience of working with a foreign partner is, the more learning and knowledge acquisition in cooperation can be increased. The type of knowledge that a foreign firm possesses (including knowledge on accounting and finance, marketing and sales, human resource management, production and operations, procurement, research and development, and general management) determines the level of overlap and complementarity of the foreign knowledge with that of the learning party.

Culture as one of the most important underlying factors has a great impact on the behaviour and culture of individuals and companies in every country. For example, in countries where teamwork and communication are cultural practices, people are more willing and skilled to relate to others, and as a result of such interactions and a necessary factor in knowledge transfer, more knowledge will be carried over to knowledge recipient firms. “In the Darkhovein Project, we were shown that working with Italians can lead to a lot of learning because they have the spirit and culture of interaction and teamwork”, said one interviewee. Conversely, individuals and companies in countries with a weaker team spirit and conservative behaviour, less willingness and skill to communicate with others, are hesitant or and reluctant to share their knowledge and experience with others.

As a result, the culture of the foreign partner country will have a significant impact on the interaction pattern and the rate of knowledge transfer. Knowledge of the culture of countries which has a significant impact on organisational culture and behaviour of individuals can help a great deal in selecting the cooperating partner, anticipating problems, and planning to rectify or minimise them.

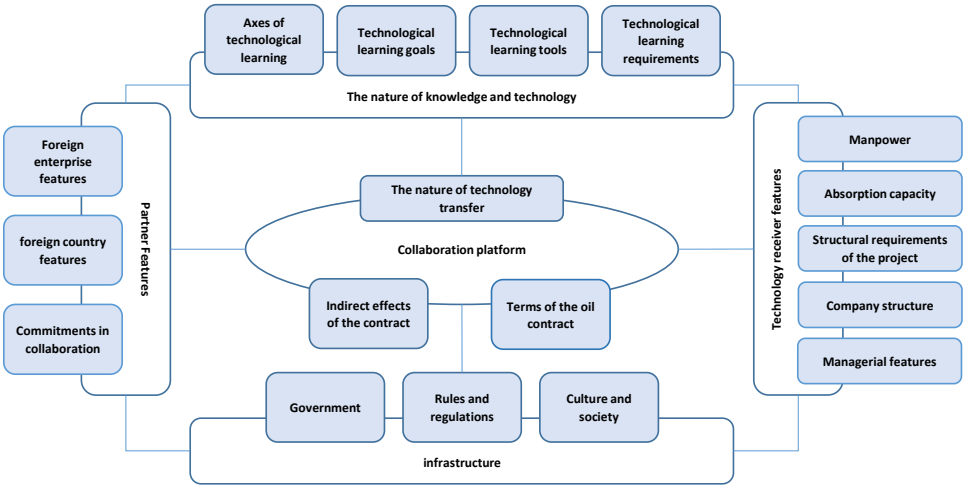
4.5 Nature of knowledge and technology

The nature of transferable knowledge, being tacit or explicit, its social complexity and the nature of technology are among the factors influencing learning in this category of

contracts. The degree of implicit knowledge or the degree to which knowledge relies on human resources is another important variable in relation to learning. Having tacit and complex knowledge is considered a sustainable competitive advantage, because this form of knowledge is highly dependent on individuals within an organisation and has a low possibility of being coded and transmitted by language, and therefore tacit knowledge transfer is usually more difficult. It requires more time and deeper communication. One of the interviewees said, "We do not have anything as a learning experience that exists academically and professionally in our state-owned company; what are the lessons learned of these contracts, what are their commonalities? What are their advantages? What are their disadvantages, where is all that? There is nothing and it should be addressed."

The social complexity of knowledge is an important resource for creating a competitive advantage, because it depends on interpersonal relationships, very unique routines and technologies that cannot be imitated. In other words, the social complexity lies in the networks of formal and informal relationships within the organisation. This social complexity and tacit knowledge is the main issue in integration of both acquisition parties. The more implicit the knowledge of technologies and capabilities and the more complex the social complexity, the more difficult it is to transfer. The more social complexity the target knowledge base has, the less likely it is to succeed in transmitting it. However, the acquisition of knowledge resources and the integration of these new resources must be done in one way or another. One of the most effective ways to facilitate the transfer of complex social knowledge is to establish rich communication. The following graph shows the proposed technological learning model in this research for foreign investment contracts of the oil industry according to the issues raised and summarised.

Figure 1 Technological learning pattern in foreign investment contracts of the oil industry resulting from this project (see online version for colours)



5 Discussion and conclusions

In this pattern, the main categories and sub-categories affecting technological learning in reciprocal sales contracts and their relationships are shown. This framework has five main categories including the nature of knowledge and technology, the characteristics of the technology recipient, the characteristics of the foreign partner, the country's infrastructure and the context of cooperation. These categories have in a two-way interaction and directly or indirectly affect technological learning. Indeed the findings of this study show that in the field of technology, there are initial and potential capabilities to make technological changes and learning events. However, looking at the technological outputs and the current state of the oil industry shows that these potential capabilities could not be properly realised. This has prevented a visible change in the field of technology in the oil industry. The release of new technologies in the oil industry requires the connection and interaction of actors in different parts of the value chain. New technologies can enter the system of the oil industry when the interactions within the system as well as the macro conditions governing the system provide an opportunity to participate in the system. These technologies need a structure for their operation that provides system of the oil industry, infrastructure, networks and the required platform for this purpose. Finally, after matching the research findings with the project documents, the content that can be learned and transferred in foreign investment contracts is presented as follows:

- gaining the knowledge of know-how
- transfer of reservoir management knowledge
- transfer of integrated management knowledge of field development and operation
- transfer of world's updated and advanced equipment and devices
- transfer of licenses for special field development and production software
- transfer of technical knowledge to companies, research and development centres and active personnel
- technology transfer in the field of control systems
- technology transfer with the aim of optimising processing and operation facilities
- transfer of field operation technology after development
- transfer of technical knowledge in the field of new technologies
- transfer of technical knowledge in the field of oil field development
- transfer of equipment manufacturing plants.

6 Research suggestions

Finally, according to the findings of this study, some policies are proposed to increase technological learning in future contracts:

1 According to findings of this study, it is suggested that the host country in each contract identify a technology as its priority and only try to localise that particular technology. It also eliminates classical teaching and research and development that are practically impossible. Also, considering that one of the main necessities in developing countries is to create long-term jobs, it is suggested that the Ministry of Petroleum separate its operational units and build an oil plant township to localise only one technology in each contract.

2 According to the interviews conducted with senior managers of the oil industry, it is necessary for the policy-making body to identify its technological needs and demand the transfer of technology. It has sometimes been observed that technology transfer methods are repeated beyond the needs. Also, in order to employ the suppliers of the host country, the contractor should make previous arrangements and anticipate issues, following which the contractor is required to use domestic suppliers.

3 Supporting programs that affect interactive learning is also a policy proposal. Thus, different interactions in the field of learning can be divided into contacts with scientific associations, national universities and international universities and companies, or technological collaborations with competitors, suppliers and customers. Learning happens through interaction by means of foreign investment of international companies and joint ventures.

4 The role of the government as one of the components of the governance structure in improving the process of technological learning is also very important. A valuable suggestion in this regard is to inform policy makers of the technology-based development and growth approach. This awareness should lead to the development of policies focused on technology development and guide firms toward localisation of technology and development rather than focusing on maximising production capacity.

5 In the field of culture, weak team spirit, xenophobia, lack of strategic alliances, reluctance and lack of necessary grounds for the development of common goals and sharing of knowledge and information are among the country's weaknesses. Holding training courses focused on knowledge management, teamwork and social participation can change the social attitude towards this issue.

6 Another important issue is the subject of benchmarks for the purpose of evaluation and quality measurement. The existence of international sanctions in recent years has taken a serious toll on this sector, and Iranian companies in the development of technologies in the oil industry are faced with a lack of relevant set of standards.

7 Regarding laws and regulations, the existence of various legal provisions in the field of technology development in the oil industry, which sometimes suffer from imbalances, leads to complexity and confusion of actors in the field and results in missed goals. This needs to be fundamentally amended to facilitate the path for actors with up-to-date and efficient laws and transparency. Technology transfer laws must be clear and in writing, and the Ministry of Petroleum must regulate and address the needs as well as corresponding laws in accordance with the terms of contracts in this field.

8 Since the knowledge that is to be transferred in each contract is to be delivered to the Ministry of Petroleum, it is suggested that capacity building be done not only at the level of the project implementing company, but also at the higher ministry level. To that end, knowledge must be organised and transferred from individuals to the organisation and documented so that it is not dependent on a certain individual's presence. The lessons learned in each project should be documented not only at the management level, but also by experts in each project.

9 It is suggested that instances of technology transfer be quantified so that they can be measured. For example, the objectives of the training courses and how to measure the acquired skills should be clearly defined. Or, in the discussion of research and development, the goals and findings, how to have a share, and the advantages of the results should be specified. Also, proper structure should be established to implement technology transfer clauses, and fixed regulations should be developed and communicated for their implementation (Jennings et al., 2000).

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Notes

1 China National Petroleum Company

2 Italian Energy Company