Knowledge Management Pattern for Project-Based Organizations in Energy Industry: A Grounded Theory Study

Masoume Amidi[a], Gholamreza Hashemzadeh[*b] and AliAkbar Alizadeh[c]

[a] PhD student of IT Management , Management Department , IT management Faculty, South Tehran Branch,Islamic Azad University, Tehran, Iran, Email: m.amidi@nioc.ir
[b] Associate Professor, Management Department , IT management Faculty, South Tehran Branch,Islamic Azad University, Tehran, Iran, Email: gh.hashemzadeh@azad.ac.ir
[c] Head of Personnel Department, National Iranian Oil Company, Tehran, Iran , Email: aliakbar.alizadeh@nioc.ir

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ABSTRACT

Knowledge management (KM) has been considered as an important competitive advantage for all kinds of organizations, including energy sector. Executing research and development (R&D) projects of energy industry (RDEI) will create, share, and reuse a huge amount of knowledge, and few organizations know how to manage it effectively. Thus, finding a customized KM pattern which matches specific factors of the RDEI is a major concern of managers. This paper aims to present a customized KM pattern for the R&D projects of the studied sector considering project-based organization characteristics by using grounded theory. Needed information is gathered by semi-structured interviews with experts. By using open, axial, and selective coding, the components of the final model and their relations were found. The results showed 48 open codes, 15 main and 5 secondary concepts which were all formed in "causal situations", "intervention situations", "strategies", "pivot phenomena" and "effects".

1. Introduction

Knowledge management (KM) has received considerable attention in the energy sector (Ranjbarfard, Aghdasi, Lopez et al., 2014), which is because of the crucial role of knowledge in generating productivity and its importance in the global economy (Zhao, De Pablo & Qi, 2012). KM has different definitions. One definition is a systemic and organizationally specified process for acquiring, organizing, and communicating both tacit and explicit knowledge of employees so that other employees may utilize it to be more effective and productive in their work (Ahmed, 2017). According to another definition, KM is a process in which an organization generates wealth from its knowledge or intellectual capital (Nonaka and Takeuchi, 1995). Moreover, knowledge is unique as an organizational resource in that the value of knowledge as a resource rises during use while that of most other resources diminishes (Youssef, 2016). KM is essential for many companies due to its role in a competitive advantage. (Allameh, Rashid & Abbasi, 2015). That is why global oil and gas companies are at the forefront of KM development (Bairi, Manohar & Kundu, 2013). Despite the importance of knowledge as an asset, few organizations know how to manage knowledge effectively (Bairi et al., 2013). An enterprise knowledge management model is one of the important issues for an effective KM (Zhao et al., 2012).

In the selected industry, KM and its model are managers' significant concerns. That is due to the two main reasons; first, the companies of the selected energy industry are in different locations, and each of these companies is not entirely aware of other experiences (Tavallaee and Taheri, 2013). The model of KM in project-based organizations (PBO) can help reduce the cost and improve efficiency and effectiveness in decision-

* Corresponding Author

making and operations by mediating the role of mediation and communicating between the knowledge seeker and the resources required (Allameh et al., 2015). Secondly, by dismissing staff from the organization, the industry will lose much of its knowledge and skills (Tavallaee, 2008).

Moreover, because of the characteristics of project-based organizations (PBO), KM of these types of organizations should be studied separately (Müller, Pemsel and Shao, 2014; Pemsel, Wiewiora and Muller, 2014); hence, the KM model of PBOs has become an exciting topic. On the other hand, many investigators (Faraji, 2009; Tadayon & Pezhan, 2006; Tadayon & Yadegar, 2009; Hamidizadeh, 2009) proposed KM patterns which are limited to one KM process.

In order to fill the mentioned gap, this study aims to provide a KM pattern for R&D projects by using the grounded theory (GT) approach and with a glance at the native characteristics of the selected energy industry. Therefore, the contributions of this study are as follows: First, the presentation of the KM pattern has focused on the characteristics of PBO of the energy industry. Second, the KM method has been used by the grounded theory, which has been underestimated in the works on the KM model of energy industry PBOs. Third, the proposed pattern covers the entire KM processes, while many of the previous KM researches on the selected industry are limited to one of the KM processes such as knowledge sharing process.

The remainder of the paper is organized as follows: The literature is first reviewed, and the data collection process and GT methodology are then explained. The last section deals with the results of the findings. Finally, the conclusion and discussions are presented.

2. Literature Review

In this section, some critical studies of recent works related to KM patterns are presented. A socio-technical model is presented for the eastern European civil discipline in 2010. In 2012, Zhao presented a KM model based on China experience. In 2013, Patalas-Maliszewska reported a model for knowledge sharing in the manufacturing system. At the same time, a Chinese study is conducted in which the main dimensions of KM model are found and categorized in "systems," "applications," "methods," and "observations." In many studies related to the energy industry, PBO characteristics are not considered (Faraji, 2009; Tadayon et al., 2006; Tadayon et al., 2009). Moreover, many of the papers about PBOs mainly focus on parameters and factors, and the final model is less emphasized.

Table 1 shows that in international research, the KM patterns presented are in regard to the characteristics of a particular industry and country. Thus, there is a particular necessity to find a customized model for the R&D projects of under-investigated energy industry regarding PBO issues.

3. Research Methodology

In order to fill the mentioned gap, the main objective of this qualitative research is to provide a pattern of KM for R&D projects of the selected energy industry.

Table 1: Overview of previous important research

Writer	Subject	Description
A) KM model papers (which have not considered PBO properties)		
Youssef, 2016	Knowledge sharing model	Only focused on sharing
Okeke, 2013	Knowledge management model	In a specific Nigerian National Oil Petroleum Corporation
Li, Liu, and Zhao, 2018	A model for knowledge creation	Knowledge creation only
Jeon, Kim and Koh, 2011	Knowledge sharing model	Focused only on sharing
Zhao et al., 2012	KM model based on China experience	PBO is not considered Limited to a special country
Patalas-Maliszewska, 2013	Model for knowledge sharing In the manufacturing system in Poland	Knowledge sharing only
Handzic, 2011	Socio-technical model	Specialized in eastern Europe and civil discipline
An, Deng, Weng et al., 2013	Four dimensions are found: systems, applications, methods, and observations	Only for China Only four dimensions
Faraji, 2009; Tadayon et al, 2006; 2009; Hamidi-Zadeh, 2009	KM in the oil industry	In some works, only one process or specific comanies is studied. In the other, PBO is not mainly focused.
B) Papers regarding PBOs		
Akhavan, Zahedi and Hosein, 2015	KM barriers in PBOs	Only focused on barriers
Muller et al., 2014	Identifying enablers in PBOs.	No model is presented.
Mousazadegan, Esfandi, and Nikjou,2016; Safari, Parhizkar and Rabiee, 2010	The necessity of KM in PBOs and Identifying KM factors	Case study No models are presented.
Salehi Taleshi, Hosseinalipour, and Arbabi, 2017	Identifying and evaluating KM infrastructure in KM oil industry	Relation among factors are not studied.
Akhavan, Jafari and HassanNejad, 2016	Model for knowledge sharing in PBOs	Case study model is limited to one process.
Ren, Deng and Liang, 2018	Finding knowledge transfer factors in PBOs	Limited to one country and one industry No model is presented.

This study is an interpretive and qualitative research. To this end, the grounded theory approach was used. Its secondary objectives are identifying the causative conditions, the intermediary elements, the strategies, and the impacts of implementing KM in the R&D projects of energy industry. Therefore, according to the objectives, the research questions are set forth as follows:

- What are the leading causes of KM in the PBO of the selected energy industry?
- What are the factors affecting KM in the R&D projects of the selected energy industry?
- What are the KM strategies in the R&D projects of the selected energy industry?
- What are the underlying factors of an organization related to the KM in the R&D projects of the selected energy industry?
- What are the implications of implementing KM in the R&D projects of the selected energy industry?

The research methodology was conducted by using the grounded theory, which is a qualitative research methodology and uses a systematic set of coding procedures to develop a fundamental theory arising from the induction of a phenomenon (Corbin and Strauss, 1990).

The most critical issues in this strategy are codes, results, and primary and secondary categories (Pandit, 1996). Three types of coding are applied in this method as listed below. (Glaser, 2002 quoted from Loghmannia, Khamassan, Ayati, et al., 2010):

-Open Coding: An analytical process through which identifiable concepts and their features and dimensions are discovered in the data.

- Pivot Coding: The process of converting concepts into categories. This encoding is considered to be the central axis of coding around the axis of a category. At this stage, the fundamental data theorist chooses a concept of open coding step and considers it in the process; then other concepts are added to it.

To have a basis for finding the time to stop sampling from different groups related to that category, Glaser and Strauss proposed a theoretical saturation criterion (Loghmannia et al., 2010). Javadi (2013) has emphasized on the appropriateness of using of grounded theory as a rather new methodology to get rich and first hand data in developing countries.

The statistical population of the study included ten experts who were experienced (at least ten years of experience) in 7 different R&D projects and were familiar with the issues of KM. Meanwhile, familiarity with the issues of managing the projects of the energy industry was a priority. Table 2 shows the demography of the interviewees.

The study was continued by interviewing the experts, and the interviews with key experts were considered as a starting point for research. The selected people were chosen in a targeted and snowball manner in positions related to KM, both human resources and technology of selected industry departments. In this study, after six interviews, the saturation stage was reached, but it was continued until ten interviews. Each interview lasted around 30-40 minutes. Their answers were noted, and the key elements were then extracted.

The main questions asked are listed below:

- What do you know about (or what is your conceptualization of) KM?
- Given your experiences, why do you need KM in your company?
- What are the differences between KM in your company and other companies and industries?
- Did you have any successful KM project in your company? What were the challenges?
- On which areas, KM in PBOs will have an impact?
- How much do the stakeholders and external factors of your company use KM?

Table 2 : Demography of the interviewees

Expert No.	Position	Experience (year)	Age	Gender
1	Manager of Pr1	8	30-35	Male
2	Manager of Pr2	15	40-45	Male
3	Senior Manager of Pr1	10	40-45	Female
4	Researcher of Pr4	12	35-40	Male
5	Researcher of Pr2	10	40-45	Male
6	Researcher of Pr3	20	50-55	Male
7	Researcher of Pr4	18	35-40	Male
8	Manager of Pr5	12	40-45	Female
9	Researcher of Pr6	17	45-50	Male
10	Manager of Pr7	9	45-50	Female

4. Results/Findings

Data were collected by interviewing ten experts. An example of the interviews is given below.

A) What are the differences between the management of knowledge in research projects of your industry and other industries?

"… Creativity and rapid synergy with new technologies are the main issues in the success of the project. Providing an appropriate communication platform for knowledge sharing and timely communication between project members is very

important ….”

B) What is required to manage knowledge in project-oriented research companies of the energy industry?

“… The technology development speed is an important challenge for our company…. Using the experiences of similar projects can have a huge impact on reducing costs and parallel works ….”

C) In which areas, can KM help your company?

“… The acquisition of knowledge from contractors and consultants is one of the important issues of our company. We should ensure that, after the completion of the project, the knowledge of the product delivered to the company should be fully transferred ….”

D) What are the challenges of KM in project-based organizations in the energy industry?

“… The displacement of project people and the lack of integrated structure can make knowledge sharing difficult ….”

“… Improving readiness to acquire new knowledge is another important issue of this company. Generally, older people are more resistant to learn new things ….”

In analyzing the interviewees’ data, the following steps for open, axial, and selective coding were carried out using the methodology described above; 48 principal open codes, 16 subcategories, and 5 main categories were identified and summarized in Table 3.

The categories that have been found are based on the opinion of the expert group selected in the survey and include “organization context,” “causal conditions,” “strategies,” “intervening factors,” and “effects and results of KM.”

The factors of organization context shape the nature of the situation, the circumstances, or the problem in which individuals interact from the micro to macro levels (Dortaj, Sharia, Abbaspour et al., 2017).

In particular, the underlying organization factors in this study are organizational type, organizational stakeholders, and project types. For example, the scale of the project, output type, and client expertise can differ in various projects.

The causal conditions are factors making or affecting the primary category (Dortaj et al., 2017). Concepts derived from the underlying conditions include external stimuli and internal empowerment, as outlined in Table 4.

The external stimulus, including market opportunities and threats and national policy for supporting KM can be considered as the environmental factors which influence the KM process.

Organizational empowerment includes policies, trainings, contracts, agreements within the organization, formal documents, standards, cultural rules, beliefs and values, and so on.

Strategies represent the interactions or actions which activists have presented (Dortaj et al., 2017). The strategies shown in Table 5 are divided into two parts; the first part

Table 3 (cont.) : Organization context

Title	Example properties
Organization	The reputation of the organization Number of employees Organization structure
Organizational stakeholders	Dependency on partner Frequency of communication Sponsorship
Project types	Scale of project Output type Client expertise Dimensions of knowledge of project

Table 3 : Main open codes

Number of employees	The reputation of the organization	Projects management offices	Dependency on partner	Frequency of communication	Sponsorship
Scale of project	Output type	Client expertise	Dimensions of knowledge	Projects management offices,	National Policy
Market opportunities and threats	Organization strategy	Project contracts	Trust	Result-oriented culture	Official order
Readiness for new technology	Communication of practice	Similarity of projects	Coaching	Team working	Virtual teams
Inflexible organizational structure	Human capital	Customer capital	Structural capital	Seminar	Regular training
Job insecurity	Effectiveness in project selection	Knowledge complexity	Human capital	Customer capital	Structural capital
Lack of motivation	New knowledge	Reduced cost of ineffectiveness	Time index	Quality	Standards
Process documents	Lack of motivation for new technology	Lack of adoption of new technology	Cost of new technology	Team working problems	Ineffective communication

is related to informal one, including coaching activities, a combination of skilled and unskilled, and the rotation of employees in different groups. Another formal strategy includes seminars, training, recruitment and training, and communication of practice (CoP).

Interventional factors include organizational barriers and technological barriers. Examples of organizational barriers are the organizational structure of a non-formal organization, job insecurity, and weak management of R&D projects. Technological barriers are related to difficulty in the adoption of new technology, the high cost of new technology, the low motivation for applying a new technology etc.

KM Effects and Results

The successful management of knowledge in R&D projects can improve project selection and project performance in various aspects. Moreover, it can enhance the organization's existing knowledge, intellectual capital, financial, performance, etc.

In this study, it is found out that KM can improve the knowledge area of the organization through factors such as "number of knowledge assets," "complexity of knowledge," and "number of knowledge users." Moreover, intellectual capital can be improved by KM through "human capital," "customer benefits," "structural capital," etc.

Employees' motivation, job satisfaction, and learning improvement are human capital criteria which are affected by KM. In the customer's capital area, elements such as market share and annual sales per customer can be affected by KM. In the area of the process, the ratio of administrative costs to total capital, process time, etc. can be mentioned. Another impact area of KM is related to the financial sector, including the ratio of profit to assets, return on capital to assets, etc. The mentioned KM results are listed in Table 7.

Tables 2-7 have resulted from the open coding phase. Next, we continue with axial coding to find out the connections among categories. Finally, through selective coding, the core category is identified, and the KM pattern is introduced as discussed later.

In order to choose a core category, some features summarized in the following should be considered (Danaee Fard and Imami, 2007):

- The category should be axial, which means all the other main categories can be associated with it.
- It should frequently appear in the data, which means that, in most cases, there are signs that refer to that concept.
- This concept should be able to explain contradictions or substitutes within the framework. Thus, the core category is considered as "KM in R&D projects," which has the above conditions.

Figure 1 below shows the final KM pattern achieved.

Table 4 : Casual situation

Title	Example properties
External driving force	Market opportunities and threats, an official order, national policy
Organizational enabler	Regulative: Organization strategy Project contracts Normative: Training Process documents Standards Cultural: Trust, result oriented culture Readiness for new technology

Table 5 : Strategies

Title	Example properties
Informal strategy	Coaching, team working, and virtual teams
Formal strategy	Seminar, communication of practice, and regular trainings

Table 6 : Interventional situation

Title	Example properties
Organization barriers	Inflexible organizational structure Job insecurity Lack of motivation Weak R&D project management Ineffective communication due to culture Low ability to team working
Technological barriers	Lack of motivation for a new technology Cost of a new technology Difficulty in the adoption of a new technology

Validation of the pattern

One of the validation methods of the pattern is the validation by respondents (Dortaj et al., 2017). The results of coding were presented to the research team to verify the

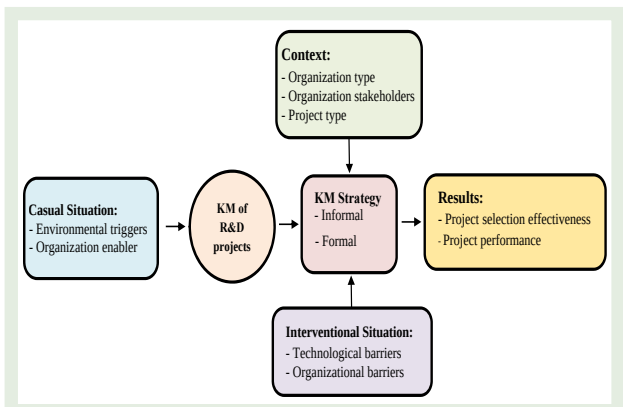

Figure 1 : KM Pattern of the R&D projects for the studied energy industry

Table 7 : KM effects and results

Category		Example properties
Project selection		Effectiveness in project selection
Project execution	Knowledge	New knowledge, knowledge complexity
	Intellectual capital	Human capital, customer capital, and structural capital
	Financial	Reduced cost of ineffective projects
	Innovation	Number of patents, new products
	Process	Time index, quality

validity of the findings. The final pattern was given to the respondents, and their opinions about the conceptual pattern were asked. The index to find the reliability among the group is the Kappa coefficient which is described below:

$$K=\frac{(P_0 - P_e)}{(P_1 - P_e)}$$

Equation 1: Kappa coefficient

Where, p0 is the relative observed agreement among raters, and pe is the hypothetical probability of chance agreement which uses the observed data to calculate the probabilities of each observer by randomly seeing each category. The Kappa coefficient reflects the agreement between the two encoders. The resulting index is equal to 0.83, stating that the severity of the agreement is almost complete (Landis & Koch, 1997) and the pattern is understandable for the interviewees. Therefore, the accuracy of the proposed pattern is confirmed.

5. Conclusion and discussions

As discussed in the above sections, the KM patterns of PBOs presented in other works are tailored to a specific industry in the country, and the selected projects of energy industry need to have a customized pattern which is in line and consistent with its native characteristics; these features are relatively neglected in previous research on KM of selected energy industry. Therefore, in order to fill this gap, this research aimed to present a knowledge management pattern to the R&D projects of the selected energy industry. To this end, the data were collected by reviewing the semi-constructed interview with the experts in energy industry, and they were codified by the ground theory approach. Therefore, the final pattern was presented by taking into account the aspects of the project related to the energy industry in the country. The results of component grouping are causal conditions, strategies, interventional conditions, organizational context, and the effects of KM.

Knowledge management has internal and external causative elements. The status of competitors, market threats and opportunities, and contractors on the one hand, and internal stimulants, including significant organizational policies, country perspective document, etc. on the other hand are among the important factors affecting the KM implementation in the R&D projects of energy industry. The competitive environment of the energy industry in the region is changing rapidly. Knowledge is one of the main factors in gaining a competitive advantage.

Various retirement reasons such as low payments in operational areas and migration to other organizations causes employees to leave selected R&D projects. Regarding the range of the employees' age, several managers and professionals with a background will retire in the coming years, which can withdraw their expertise and experience from the organization and can lead to huge loss of skills. Therefore, planning to preserve and transfer their experiences needs to be emphasized. Training and knowledge transfer procedures are also needed for new staffs to compensate for this knowledge gap.

The organization context factors of KM are related to the type of organization and R&D projects such as product scale, organizational structure, and stakeholders. As one of the experts emphasized, "…During the projects lots of experience can be gained, but knowledge reuse is difficult due to high changes of staff …."

In the energy industry companies, the geographic distance and the range of employees age vary. The feeling of job insecurity in experienced people makes it difficult for younger staff to find their knowledge and experience. Therefore, building trust in business relationships between project partners is one of the issues affecting knowledge sharing and recording experiences. Improving managers' opinion about the significance of knowledge and sharing knowledge and changing their leadership style play a great role in enhancing knowledge management culture.

KM strategies are divided into two types, namely the informal strategy including virtual teams, coaching activities, and so on and the formal one, including learning before entering the project, research seminars during and after the

project, etc.

The implementation of KM in R&D projects of the selected energy industry will face intensive barriers such as organizational barriers and technical barriers. Therefore, more studies should be performed to identify different groups of barriers, and effective measures should be taken to avoid them. The significance of critical success factors has been emphasized by experts especially when the missions of the energy industry and its specification such as being project-based and government-oriented is considered. The lack of the utilization of a new modern technology is one of the problems of the selected R&D projects for the successful implementation of KM. As one of the experts stated, the low incentive measures for using technology and the low resources allocated to this issue are among those problems. Moreover, employees are not entirely familiar with modern technologies, and moving towards new technologies requires new policies and specific planning.

At the end of a pattern found by the grounded theory, the consequences of the central category are introduced. Regarding the R&D projects, the KM may mainly be used in different areas of effective project selection, knowledge, intellectual capital, financial, process, and innovation. As the experts emphasized, now a lot of the staff time is spent on finding an appropriate document; KM reduces their lost time. Many energy companies have had successful or unsuccessful experiences in their projects with their contractors, which should be shared with other companies. Hence, various sectors of the industry will reduce the number of mistakes, so their costs drop. The experts emphasized that creating knowledge would lead to an increase in prosperity and would promote the national and international status of the selected companies of the energy industry. The pattern was found by using the ground theory approach and covered the components which included the R&D companies of the energy industry by taking into account the characteristics of PBOs.

It is suggested that the energy industry should carry out the following researches:

- Studying the experience of previous KM projects.
- Studying and identifying the causative drivers and the initial motivation for implementing KM in project-based companies.
- Identifying the organizational context of knowledge management in the selected energy industry.
- Studying the field of formal and informal strategies about the identified factors
- Investigating the effects of KM of R&D projects in the energy industry; it should be mentioned that energy companies have made huge profits by applying knowledge management. Therefore, the financial field is one of the most crucial areas for senior executives. For example, Chevron's acceptance of KM is due to the severe need to reduce costs in the early 1990s (Grant, 2013).

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