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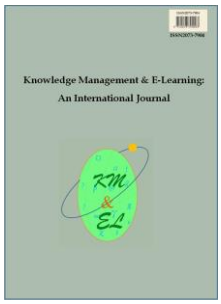
Hamid Hakamian
Mohammad Hossein Sobhiyah
Mohammad Aghdasi
University of Tarbiat Modares, Tehran, Iran
Mehdi Shamizanjani
University of Tehran, Tehran, Iran



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Hamid Hakamian

Department of Project & Construction Management
University of Tarbiat Modares, Tehran, Iran
E-mail: h.hakamian@modares.ac.ir

Mohammad Hossein Sobhiyah*

Department of Project & Construction Management
University of Tarbiat Modares, Tehran, Iran
E-mail: Sobhiyah@modares.ac.ir

Mohammad Aghdasi

Faculty of Industrial Engineering
University of Tarbiat Modares, Tehran, Iran
E-mail: aghdasim@modares.ac.ir

Mehdi Shamizanjani

Faculty of Management
University of Tehran, Tehran, Iran
E-mail: shamizanjani@ut.ac.ir

*Corresponding author

Abstract: The Portuguese navigation system was established in the 15th century as the first learning organization (LO) and achieved great success. The high similarity of the Portuguese navigation system to Project-Based Organizations (PBOs) inspires the development of a model for Project-Based Learning Organizations (PBLOs). This study analyzed the Portuguese navigation system and its components, based on which a model for PBLO was proposed. Multiple case studies were conducted with two PBOs in the oil and gas industries in order to validate and revise the proposed model. The data was collected from interviews with 20 individuals involved in project and knowledge management in the PBOs. A total of 615 statements made by interviewees were coded and summarized as concepts in the various components of the model. Since the qualitative approach to learning organizations has been neglected and few researches has addressed the issue of PBLOs, the result of this study presents innovative findings on the development learning organizations in project-based environments.

Keywords: The Portuguese navigation system; Learning organization; Lessons learned; Project-based organization; Project-based learning organization

Biographical notes: Hamid Hakamian ihas a PhD of Project & Construction Management at University of Tarbiat Modares. His research interests include Learning & knowledge management in projects & organizations, Project Management, and maturity models. His research items were the most read research items from his department in research gate network for several weeks. https://www.researchgate.net/profile/Hamid_Hakamian.

Dr Mohammad Hossein Sobhiyah is an Associate Professor of Project & Construction Management at University of Tarbiat Modares. He has been involved in multiple disciplinary research in the various areas of project-oriented organization since 1991. He has published more than 30 papers in academic journals. Also, he is the Founder of Iran Project Management Association and the First assessor of IPMA 4-level PM & 2 PM Consultant Certificates & Delta for the Certification Body of Iran PMA.

Mohammad Aghdasi is Associate Professor of industrial engineering and is currently head of Faculty of Industrial Engineering at Tarbiat Modares University.

Dr. Mehdi Shamizanjani is Associate Professor of IT Management at the Faculty of Management, University of Tehran, Iran. His current research interests include knowledge management, project management and digital transformation.

1. Introduction

Learning is regarded as the most important activity of project-based organizations (PBOs). Learning faster than one's competitors is the most sustainable method for creating competitive advantage (Koskinen & Pihlanto, 2008, p.76). Learning is considered as a key success factor in PBOs (Sense, 2008). Although it is highlighted as one of the main drivers of performance enhancement (Bartsch, Ebers, & Maurer, 2013), learning from projects faces numerous challenges. The temporary nature of projects impedes the transfer of knowledge from one project to another and interferes with the institutionalization of knowledge in the PBO (Bartsch et al., 2013). Some have referred to this process as the learning paradox, which means that while much knowledge is generated in the project environment, it is not absorbed by the organization due to the temporary nature of the project (Turner & Keegan, 2007; Bakker et al., 2011).

Since the 1990s, the field of organizational learning has been influenced by the concept of learning organizations (LO) developed by researchers such as Senge (1991) and Pedler, Burgoyne, and Boydell (1991). The development of models specific to nonprofit, higher education, governmental, and military organizations (McHargue, 2003; Watkins & O'Neil, 2013; Stothard et al., 2015) demonstrates the need for the adaptation of models for LOs. However, models of LOs have not been adapted for PBOs. Features specific to PBOs demand the integration of various concepts of learning in the models of Project-Based Learning Organizations (PBLOs).

Issues such as time pressure for project completion (Shokri-Ghasabeh & Chileshe, 2014; Ajmal, Helo, & Kekäle, 2010; Keegan & Turner, 2001), the priority of project implementation over learning and many other issues (Julian, 2008; Bartholomew, 2005), neglecting learning in specific areas including project boundaries (Swart & Harvey, 2011; Koskinen & Pihlanto, 2008), physical distance between project teams specially in

international projects (Loufrani-Fedida, Missonier, & Saglietto, 2014; Koskinen & Pihlanto, 2008), the dominance of short-term focus in PBOs due to the temporary nature of the project (Love, Fong, & Irani, 2005; Koskinen & Pihlanto, 2008), the existence of a knowledge gap between the project and the organization, the need for facilitators and special means of transferring knowledge (Wang & Ko, 2012; Pemsel & Müller, 2012; Loufrani-Fedida et al., 2014; Loufrani-Fedida & Saglietto, 2016; Swan, Scarbrough, & Newell, 2010), and the need for focus on in-project and inter-project concepts of learning (Julian, 2008; Lampel, Scarbrough, & Macmillan, 2008; Swan et al., 2010; Loufrani-Fedida et al., 2014; Loufrani-Fedida & Saglietto 2016; Hartmann & Dorée, 2015; Cicmil, 2005) all influence learning and create a different atmosphere which calls for a distinct approach. Attempts to verify whether various models of LOs, in particular those developed by Watkins and Marsick, Marquardt, and Garvin, manage to resolve the above issues suggest that no model alone can address the specific challenges of project environments (Hakamian et al., 2015). These models mainly focus on the dimensions and the support that organizations need to provide, and have paid less attention to learning processes and mechanisms. Also, the use of inductive approaches based on real data from the particular context of PBOs has also been neglected. Thus, this study considers processes and learning mechanisms that are important in PBOs (Gasik, 2011; Loufrani-Fedida & Saglietto, 2016; Boh, 2007; Duffield & Whitty, 2015), while addressing related contexts that should be created for knowledge management in the organization. This paper proposes a model inspired by 15th-century Portuguese Navigation System (regarded as the first LO). By deploying a system of learning from experiences through the School of Sagres, the Portuguese system achieved great success during the 15th century (Milton, 2010, pp.13–14). Each voyage in this system can be considered as a project with a start and end time, a unique outcome, specific lessons learned, as well as countless uncertainties. Therefore, this system can be considered not only as the first LO but also as the first PBLO. Hence, this paper develops a model of PBLOs based on the Portuguese navigation system in the 15th century. Then, the model is examined and validated based on data obtained from a case study of two PBOs. Finally, the model is modified, and a revised version is presented.

2. Learning in PBOs

PBOs are a class of organizations whose products are often made upon customer orders (Ajmal & Koskinen, 2008). Within these organizations, either most activities are carried out as projects or, the project aspects are regarded as more significant than the task aspects of the structures and processes of the organization (Lindkvist, 2004). As shown in Fig. 1, projects are introduced in the organizational structure in order to accomplish a specific objective.

This Figure shows the difference between a PBO and standard organizations. In PBOs, projects, which are temporary, create a new structure within the organization. It should be noted that in this type of structure, projects are especially useful for learning purposes because of their special nature as secondary types of organizational structures. However, there is a major difference between a need to collect data and the real application of the data (Schindler & Eppler, 2003). Various forms of learning occur within this structure:

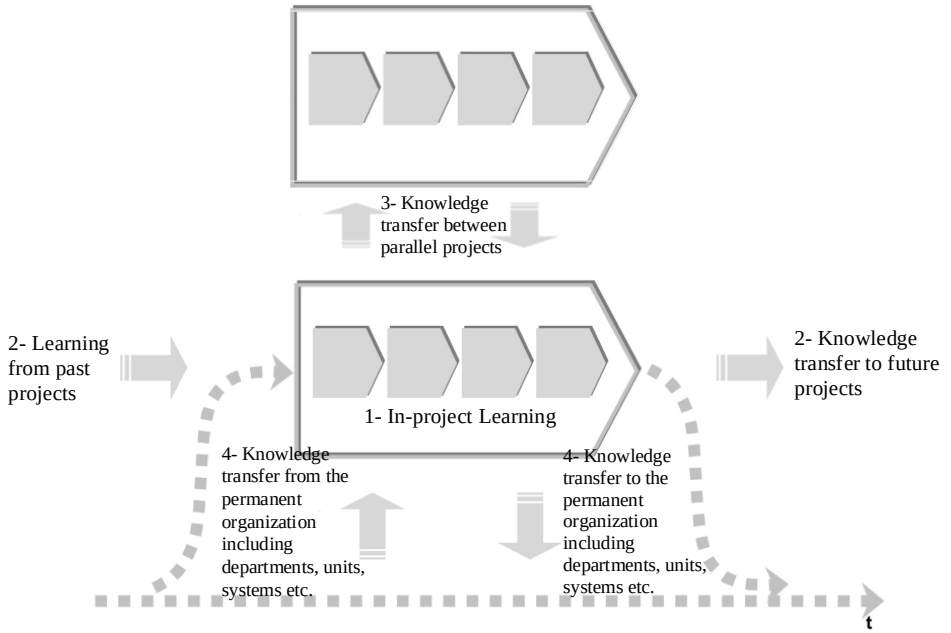

Fig. 1. The structure of learning in PBOs – Adapted from Disterer (2002) revised model and Lindner and Wald (2011) model

1. **In-project Learning**: (Davidson & Rowe, 2009) note that learning should occur throughout the project and should not be delayed until the end. It should also be noted that project environments are fertile grounds for learning because a lot of knowledge is gained during the project (Bakker et al., 2011). If carried out systematically, the project learning cycle can be effective both on project & PBOs performance. (Davidson & Rowe, 2009; Kotnour, 2000).
2. **Learning from past projects and knowledge transfer to future projects**: The Enhancement of experience gained from other projects and the application of knowledge acquired from past projects are among the issues noted by various researchers in the fields of learning and knowledge management in PBOs. (Terzieva, 2014; Hanisch et al., 2009; Lindner & Wald, 2011; Kotnour, 2000). In cases where one project is carried out immediately after another, there is a higher possibility for the transfer of knowledge and experience (Prencipe et al., 2005). If the projects are long or there is a long interval between projects, the permanent sections of PBOs play a more significant role because the acquired knowledge is expected to become entrenched in the parent organization and be used in future projects (Prencipe et al., 2005).
3. **Knowledge Transfer to/from the Permanent Organization**: One of the important issues highlighted in research on learning and knowledge management in PBOs is the role of the permanent sections of an organization in acquiring, entrenching, and reusing knowledge in projects (Pemsel & Wiewiora, 2013). In other words, in projects with appropriate interactions, the lessons learned while the project is being implemented can and should be transferred to the permanent organization (Sense, 2011; Lampel et al., 2008). In fact, the PBO creates the required conditions for inter-project learning to occur, to facilitate in-project learning and to transfer experiences from one project to another appropriately.

Only then can we say that a PBLO has been established. In this regard, the concept of a PBLO will be introduced and explained using a historical case.

3. A historical case as an example of a PBLO

In the 15th century, the Portuguese Navigation System (PNS) was established as the first LO with help from the Sagres School, which was the most advanced maritime study and research center of the time. At the time, sailors ventured into to unknown locations, which was highly risky. Despite the threat to their lives, they had realized that knowledge and new learning were, in fact, the most valuable souvenirs from those journeys. Before captains planned their expedition, they had to attend the Sagres School and discuss their past journeys, lessons learned, and successes with colleagues. They had to study the existing maps and make a copy of them. They were trained in the principles of navigation and mapping and read the logbooks of past navigation. After the expedition, they had to record the lessons learned and, more importantly, their maps in the form of a logbook. The knowledge gained created an enormous competitive advantage for Portugal against England and Spain, which were its main competitors for new territories. This system was strongly supported by the King of Portugal and was considered as a matter of life and death for sailors (Milton, 2010, pp.13–14). The Portuguese navigation organization can well be used as the basis for creating a PBLO. Accordingly, the structure of Fig. 2 presents a basic framework for a PBLO. The components of this Figure, as described in what follows, can inspire PBOs toward transformation into PBLOs:

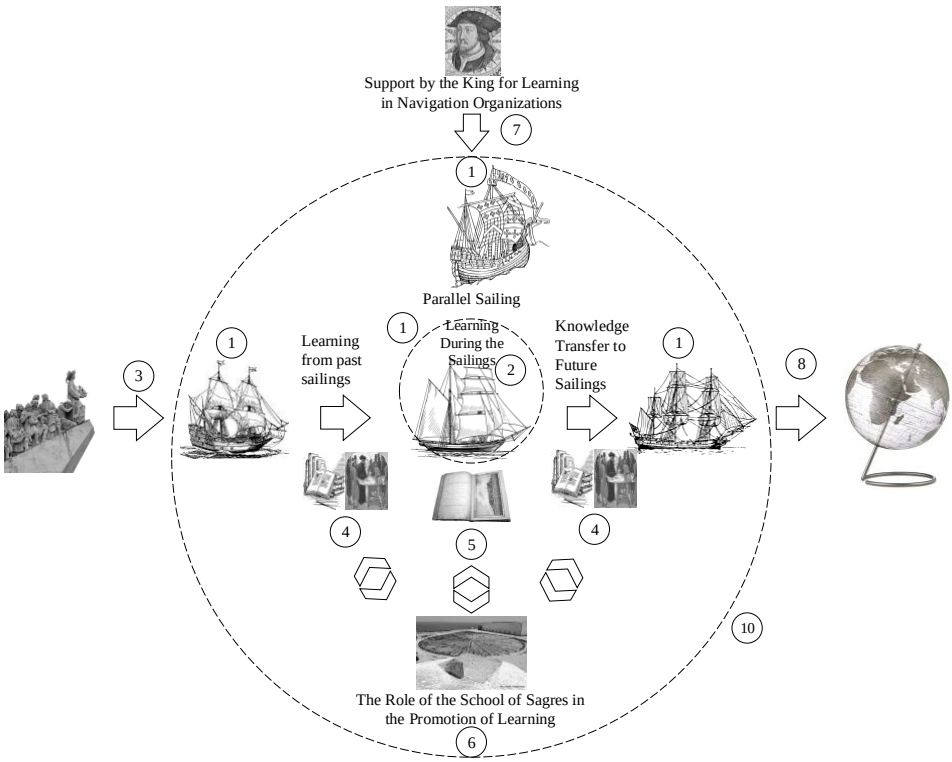

Fig. 2. The initial framework of PBLOs according to the PNS in the 15th century

1. Each journey is the symbol of a project involving uncertainty with a start and a finish date. Because of these journeys, some parts of the unknown world are discovered, which represents project objectives. This is an important difference between PBOs and standard organizations and makes the nature of learning different in such organizations.
2. In addition to resulting in new discoveries, each journey involves countless lessons learned that could not have been achieved without otherwise. This reflects the role of projects in learning. In addition to creating new products, projects are fertile grounds for learning.
3. In the Portuguese navigation system, learning from experience was considered a matter of life and death by authorities. This is why for the captains, who can be considered as project managers, learning from experience was an intrinsic necessity, not a requirement imposed by the organizational. Therefore, the biggest motive for sharing and using knowledge was an understanding of the importance of the issue by team members, not an extrinsic system.
4. Not only did the captains (project managers) and team members felt obliged to learn from experience, they also considered transferring their experiences to others as one of their key duties. Therefore, they prepared others for new journeys (projects) by attending the Maritime Forum (implicit knowledge transfer) and bringing back new maps and logbooks (explicit knowledge transfer).
5. The influence of lessons learned on logbooks and the maps brought back refers to the communication of experiences. This communication played a significant role in creating a competitive advantage for the Portuguese navigation organization.
6. The Sagres Nautical School can be viewed as a symbol of an environment that provided the basis for learning and helped sailors achieve more success.
7. Strong support for this organization by the King is similar to the role of senior organizational managers in supporting learning systems in PBOs.
8. Because of this learning structure, Portuguese sailors gained a huge competitive advantage over English competitors. This suggests that PBOs can use lessons learned to gain competitive advantages.
9. Although the communication structures of the time did not allow the transfer of lessons learned between two simultaneous or parallel journeys, team members could benefit from each other's experiences at the end of journeys.
10. In an LO such as the Portuguese navigation system, obstacles such as the negligence of lessons learned and lack of time for conceptual learning are eliminated

However, the question is "What are the components of true PBOs?" and "What processes and procedures must occur in order to achieve the status of a PBLO?" This study seeks to answer these questions.

4. A review of PBO learning models

The Systemic Lessons Learned Knowledge (Syllk) is one of the proposed models of learning in PBOs (Duffield & Whitty, 2015). This model has been inspired by the Swiss Cheese Model in the field of health and immunity which compares system defence layers to slices of cheese. Each slice has holes that represent immunity defects. A single hole

may not lead to danger because other slices play a protective role. However, if several holes are aligned, then errors will occur.

In Syllk, unlike the Swiss cheese model, holes in each layer represent facilitators of lessons learned, which cause learning to be transferred from the project to the organization and vice versa. A summarized version of the model involves six layers. The three first layers constitute the individual section of the organization (learning, culture, and interaction) and the next three layers form the system section of the organization (technology, process, and infrastructure). This model considers learning, technology, and process as key elements. Interactions and infrastructure (which highlight colocation and the existence of a public space) are more emphasized in this model.

Studies on the key success factors of knowledge management initiatives in PBOs are also useful in developing models of PBLOs.

In this context, a study by (Ajmal et al., 2010), reviews most of research in the field of learning in PBOs while identifying and introducing the following six key factors in order of priority. 1. Incentives for knowledge activities; 2. Suitable technological systems to support knowledge initiatives; 3. Coordination and cooperation among team members and departments for interacting and sharing knowledge; 4. The familiarity of organizational members, especially project team members, with knowledge management; 5. Supportive culture; 6. Authorization for knowledge activities. Also, Time pressure, a culture of blame, weak information technology, social barriers, and the view that "knowledge is power" were among learning difficulties mentioned by participants (Ajmal et al., 2010).

In addition, the study by (Hanisch et al., 2009) classifies the main factors for successful project knowledge management in four groups: 1. Information and communication technology; 2. The organization; 3. Methods; 4. Culture and Communication.

Another research notes that a failure to apply the lessons learned processes is the most prominent problem in the field of learning. Senior management, culture, and time-related issues have also been noted as common problems (Milton, 2010, p.8).

In conclusion, the following can be presented as the main factors that influence learning in PBOs:

1. Learning processes that determine an organization's response to environmental pressures and promote innovation for the purpose of gaining competitive advantage must be used in the organization in a practical way.
2. Learning, which occurs at different levels in PBOs
3. Incentive systems are provided for individuals participating in knowledge management
4. A supportive environment that provides the context and infrastructural for the facilitation of learning
5. Technologies and systems for controlling and developing knowledge

5. A review of empirical studies on learning in PBOs

Davidson and Rowe (2009) presents a systematic practical approach to learning in project environments. Their model highlights the acquisition and retention of knowledge at

decision points, which enriches individual, project, and organizational learning throughout project life cycle. This research introduces a vertical learning process through which knowledge is transferred from projects to the technical and strategic units of the organization. Various studies have stressed performance improvements in LOs (Davis & Daley, 2008; Li & Lu, 2007; Shieh, 2011; Dekoulou & Trivellas, 2014). (Reich, Gemino, & Sauer, 2014) demonstrates that if project managers promote knowledge convergence and common understanding, project outcomes would be significantly improved. This research shows that achieving higher levels of knowledge convergence (despite being costly and time-consuming) has no significant negative impact on project costs and time objectives. Another research argues that knowledgeable individuals who are empowered by both technology and the social environment can provide higher quality documentation. However, without employing systematic knowledge sharing methods, the produced documentation may not be consistent, and, as a result, the organization might fail to provide the customer with necessary value (Reich, Gemino, & Sauer, 2012).

6. The proposed PBLO model

Fig. 3 presents an initial model for PBLOs based on the 15th century Portuguese Navigation System and the results of theoretical and empirical studies in the field of learning in PBOs. The components of this model are explained in what follows:

1. **Learning**: As outlined in Fig. 1. Learning in PBOs occurs at several levels: learning within the project, learning from previous projects, the transfer of experiences to future projects, and knowledge transfer between parallel projects. In the section on empirical studies it was emphasized that knowledge convergence can lead to added value. It was argued that the creation and sharing of knowledge, which is one of the core learning activities of the organization (Yoshimichi, 1995; Holzmann, 2013; Paulin & Suneson, 2011), can lead to knowledge convergence within and between projects. This ultimately enhances project goal achievement and creates more added value for the organization (Reich et al., 2012; Reich et al., 2014). This is why knowledge sharing mechanisms have been considered separately in research on PBOs (Prencipe et al., 2005; Figueiredo, 2002; Anand, Ward, & Tatikonda, 2010; Boh, 2007; Wang & Ko, 2012). Generally, these mechanisms can be divided into two categories of mechanisms for sharing tacit knowledge (i.e. knowledge reflected in evaluations, attitudes, perspectives, motivations, etc.) and mechanisms for sharing explicit knowledge (i.e. knowledge that, unlike tacit knowledge, can be formed within a code or a language and can then be communicated) (Carrillo, Ruikar, & Fuller, 2013).
2. **A supporting culture and environment**: The second PBLO component refers to the environment and culture that supports learning:
    - **Time for Reflection**: By reducing stress at work and devoting a specific time to the review of the work performed, the organization provides a learning space. In a PBLO, time pressure does not prevent the tasks from being correctly carried out. There is also the possibility of spending more time on improvement and enhancing of work. Finally, there will be an opportunity for individuals to reflect on tasks and projects. (Garvin et al., 2008).

- **Openness to New Ideas**: In PBLOs, an atmosphere is created that promotes spending energy on new ideas. Seeking better ways of doing things and lack of resistance to new methods are among the features of such an environment (Garvin et al., 2008).

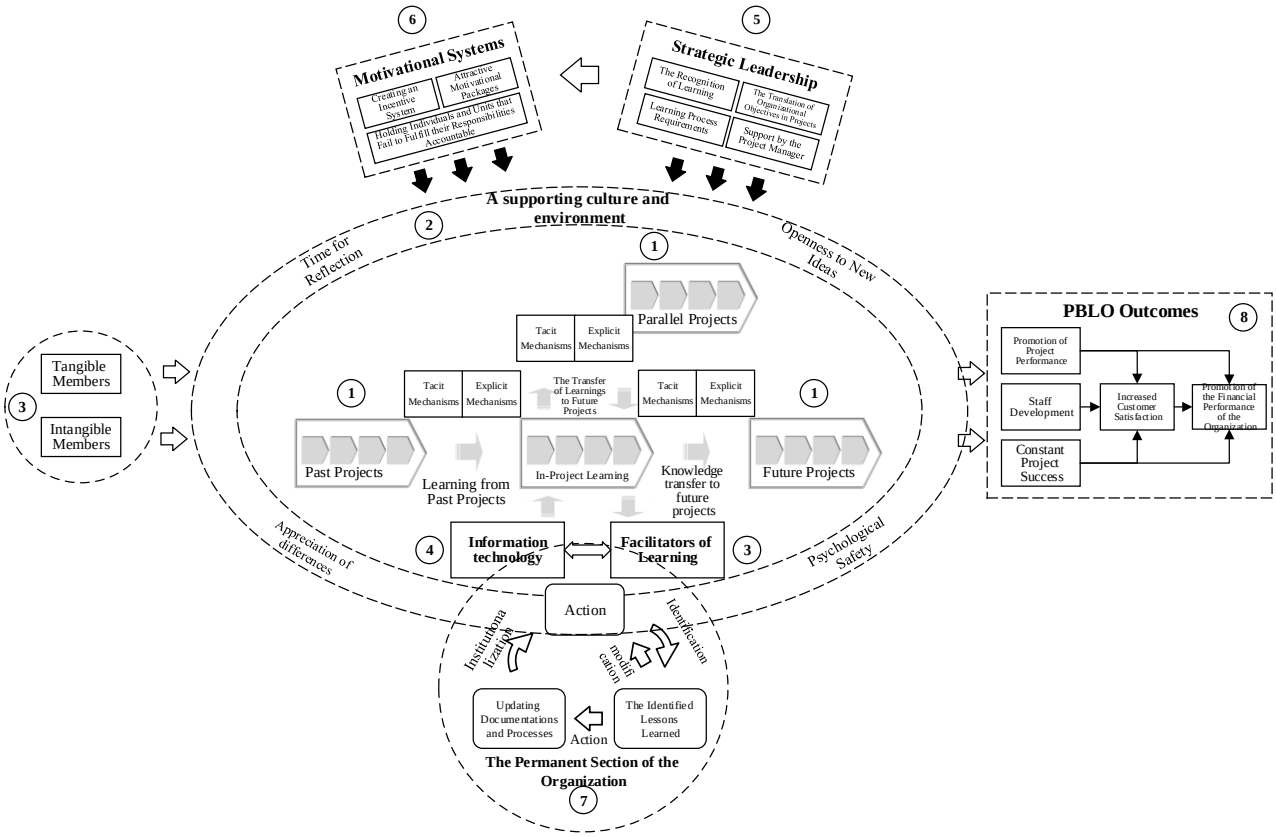

Fig. 3. Initial PBLO model

- **Appreciation of differences**: Respect for differences in views, considering unpopular beliefs, resolving conflicts in views as a group, not individually, openness to new ways of doing work and valuing new ideas.
- **Psychological Safety**: Mental security is a lack of pressure for commenting, ease of discussing problems and disagreements, lack of pressure due to mistakes, easy exchange of information about successful and unsuccessful practices, and lack of the "knowledge is power" atmosphere in the organization (Garvin et al., 2008).

3. **Learning-related Entities**: Different groups have an effect on project learning including 1. Tangible members, which are the organizational members involved in the project 2. Intangible members such as partners, suppliers and second-order contractors that have invested in the project even though they might not be project members (Ajmal et al., 2010) 3- Facilitators of learning such as the project management office (Pemsel & Wiewiora, 2013) and Communities of

Practices (COPs) (Keikotlhaile et al., 2015). Through these Entities, learning spreads across organizational borders. It also becomes possible to learn from other units, customers, employees, suppliers, and contractors. Once knowledge is shared in the internal and external network of experts, synergy is also established (Garvin et al., 2008).

4. **Information technology**: The use of project information technology plays a vital role in four areas:

    - Repository of Lessons: Allows lessons to be recorded in a standard format, assigns necessary actions to the lessons, and track lessons learned by individuals. This Repository often constitutes the bank of lessons learned,
    - Knowledge Library: A repository of PBO process documents
    - A Context for Search and Publishing: This context allows processes updated by staff to be searched and sent to concerned individuals (Milton, 2010, pp.104–105)
    - Database of skills (Watkins & Marsick, 2015): Easy and timely access to the required information (Watkins & Marsick, 2015) and being a knowledgeable user are of utmost importance. Because if users fail to find useful and suitable content in a short time (a few minutes), they will stop using the database and never return to it again (Milton, 2010, p.104). Without support for information technology tools, the knowledge management of projects faces difficulties. However, if the organizational culture does not encourage the use of such tools, even the best IT infrastructure will not be sufficient. Information technology systems should be designed within closed and isolated boundaries (Anantatmula & Kanungo, 2010).

5. **Strategic Leadership**: As points out by (Hanisch et al., 2009) support by senior management is a fundamental factor in the success of learning, which is referred to as a starting point for the support of learning in projects. The subject is also highlighted by (Milton, 2010, p.8). Researchers note that the senior management team of the parent organization should be aware of the importance and the value of project knowledge, recognize it, and do something about it (Bakker et al., 2011). Leaders should also exploit projects to advance the vision of the organization, perform coaching and leadership duties, and ensure that actions are aligned with the values of the organization (Watkins & Marsick, 2015). The strategic objectives of the organization, which are translated into project objectives, can connect projects for learning purposes. The need to translate organizational objectives into project objectives to promote learning is of utmost importance (Hartmann & Dorée, 2015).

6. **Incentive Systems**: One of the biggest barriers to learning is the lack of incentives for knowledge sharing in projects, as researchers agree (Swart & Harvey, 2011) and as previously stated, incentives are major factors in the success of knowledge management actions in PBOs (Ajmal et al., 2010). Thus, PBLOs should consider creating incentive systems involving rewards and punishments related to learning (Hanisch et al., 2009; Chang et al., 2009; Milton, 2010, p.138). This means that while supporting the design and implementation of appealing and effective incentives for conscientious individuals and units

(Ajmal et al., 2010), the individuals/units which have failed to fulfill their responsibilities with regard to learning must be held (Milton, 2010, p.138).

7. **Learning Processes**: Research recounts various processes that promote learning in PBOs. While considering learning entities, (Turner & Keegan, 2007) also refers to the role of the project review and audit as well as benchmarking, teaching, and learning processes to promote project learning. The auditing and feedback process have also been considered by (von Zedtwitz, 2002). The author notes that although assessment after project completion is a good way to improve performance, research suggests that its use is not considerable. The learning literature refers to three main steps in general: Identification (collection), distribution (transportation) and application (implementation) (Duffield & Whitty, 2015). In conclusion, the main processes in PBO learning based on view (Milton, 2010, p.16) include identification, action, and institutionalization.

Although more profound and comprehensive research is needed on the outcomes of PBLOs, research results on the subject are reviewed in what follows so that the proposed model can show the outcomes of this phenomenon to some extent.

8. **PBLO Outcomes**: LOs have indirect effects on performance such as improved creativity, increased effectiveness of organizational processes, improved customer relationship (Dekoulou & Trivellas, 2014), readiness for change (Jafari & Kalanaki, 2012), improved job satisfaction and organizational commitment (Dirani, 2009). Research has also confirmed the direct relationship between LOs and financial performance in public organizations (Li & Lu, 2007; Davis & Daley, 2008; Shieh, 2011; Ellinger et al., 2002; Farooq, 2012). Research shows that the implementation of knowledge management procedures has a positive impact on improving project management (Lierni & Ribière, 2008) and promotion of the learning capability of project operators can improve project performance (time, cost and quality) (Love et al., 2005; Sense, 2008). Both in general and project-based organizations, research highlights customer satisfaction as a result of transformation into LOs (Dekoulou & Trivellas, 2014; Dirani, 2009; Choy, Yew, & Lin, 2006; Shieh, 2011). Apart from reduced costs, other objectives have been expressed in project knowledge management: 1- Increasing efficiency and reducing risk, 2. Reducing reinvention of the wheel, 3. Improving staff deployment in the project, 4. Promotion of creativity and eventually, Continuous improvement (Hanisch et al., 2009). One of the important effects of employing experiences and promoting learning is recurrence of successful projects (Cooke-Davies, 2004) referred to as consistent project success (Being sure that the right projects are repeatedly performed correctly), which is an important level of success.

In Summary, a model for PBLOs has seven elements. These elements are 1. Learning, which occurs at different levels within a project and between projects. This learning is promoted by implicit and explicit knowledge sharing mechanisms. 2. Supportive environment and culture 3. Learning-related entities, which include both tangible and intangible members 4. project information technology 5. Strategic leadership 6. Incentive systems, 7. Learning processes that entrench learning in the PBO and make it possible to improve the outcomes of LOs.

7. Model validation

Multiple case studies have been conducted on two PBOs in order to validate and revise the proposed model. Two companies, A and B, were examined in this study. The companies had 40 and 30 years of experience, with 1,000 and 2,500 professional personnel, respectively. The companies have completed various engineering, logistics, construction, and commissioning projects in the downstream and upstream sectors of the oil, gas and petrochemical industries. Both companies are privately owned and engaged in megaprojects in the above industries. Data was collected by interviewing 20 project participants (10 from each company). The interviews were conducted with senior executives, project managers, and individuals responsible for various project and knowledge affairs. Introducing the actual experience and what is currently happening in the organization has been considered as the starting point of the study. Based on the topics discussed, knowledgeable individuals participating in the project were selected. The study was then conducted according to the snowball sampling method until reaching theoretical saturation. Interviews lasted from 60 to 90 minutes. Fourteen interviewees were project managers and managers at various phases including engineering, procurement, construction, installation, and project planning and control. In addition, interviews were conducted with human resources managers, project finance managers, business administrators, information technology managers, and knowledge management officials to complete the discussion.

8. The revised model

The process of data analysis and coding was conducted after the interviews. MAXQDA 10 was employed to code 615 statements derived from the interviews. The coded statements were then summarized in terms of concepts and categories, which resulted in the revised model presented in Fig. 4.

8.1. An explanation of the revised model

As shown in Fig. 4, the general framework for the initial model (Fig. 3) was confirmed by our case studies. Findings from our case studies have led to the completion and development of different parts of the model, which are discussed below:

1. **Learning inputs**: Learning inputs are addressed in the first step, which includes 60 codes (Table 1).

Table 1
Codes related to learning inputs

Title	Number of codes
Learning inputs	60
Intangible & Tangible members of the project	32
Instructions, guidelines, procedures & project documents	13
Interfaces	11
Specific project events	4

In addition to project team members (tangible project members), client, stakeholders, partners, and organizations involved in the project (intangible members) are among such sources of input. Findings from the case studies highlighted the importance of guidelines, project documentation, feedback systems as additional sources of inputs of the learning system. Project interfaces, which are situations where knowledge is shared between two sectors (buyer and seller, engineering internal departments, between procurement, construction and engineering departments, and between project partners) were regarded as third level input. Specific project events, e.g. when a document is edited too many times or a problem in auditing is repeated, are also regarded a learning input.

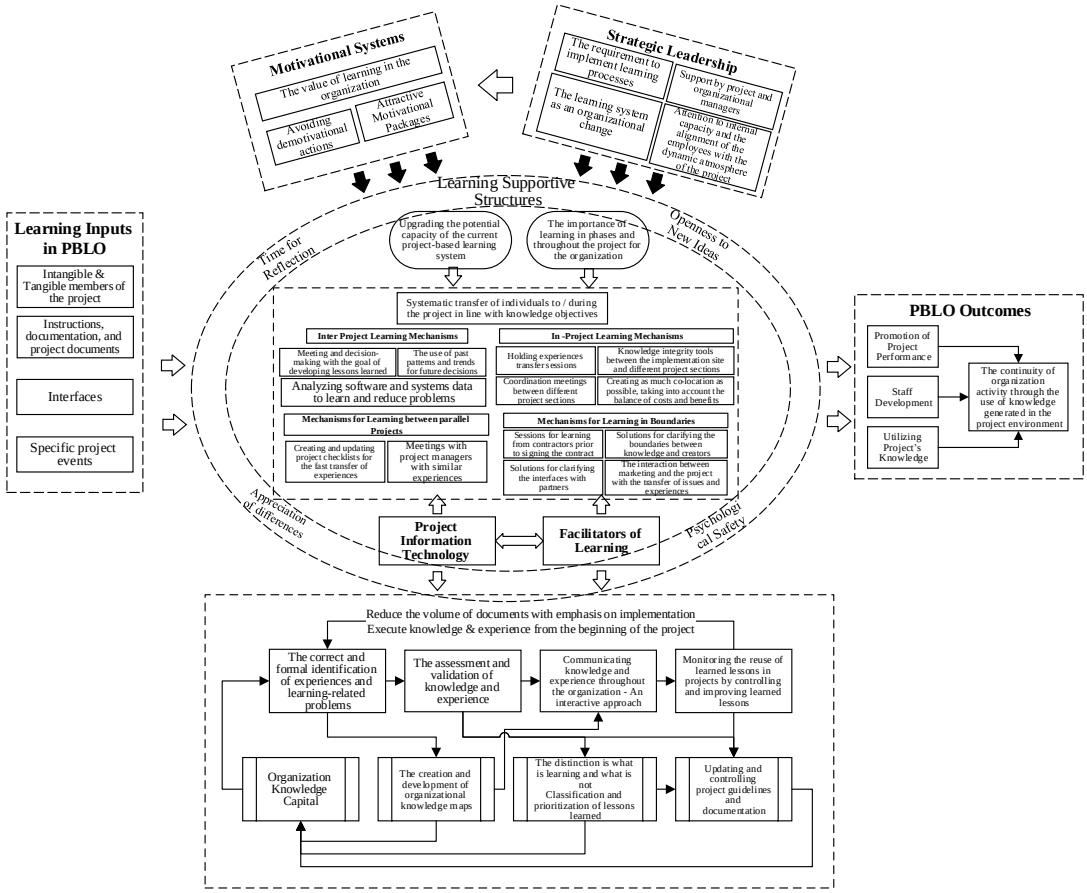

Fig. 4. The model revised based on case study findings

2. **Learning in project environments**: Based on findings from the case studies and 137 codes extracted in this section, learning mechanisms are classified as described in Fig. 5.

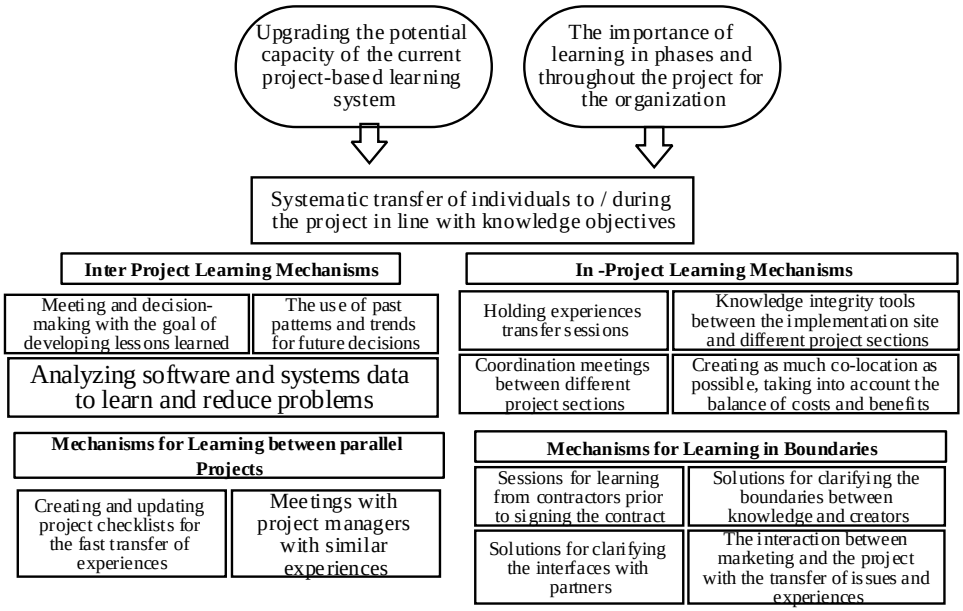

Fig. 5. Learning mechanisms in a project environment

A total of 38 codes were assigned to in-project learning mechanisms. Knowledge and information transfer between project location and the various units of the organization, the presence of the staff on a permanent basis at the project location, experience transfer meetings, and colocation were among the identified mechanisms. A total of 37 codes were assigned to inter-project learning mechanisms, which mainly addressed the use of patterns and frameworks established in previous projects and their application in future projects. In this section, meetings were also held to extend lessons. Findings from the case studies led to the introduction of learning mechanisms at project boundaries. Mechanisms for transferring knowledge between parallel projects were also discussed. One of the important mechanisms identified in the field of project learning was the systematic transfer of individuals to projects according to knowledge objectives. Determining the core team of the project using specific evaluations under the supervision of the organization, using individuals from internal and external networks to fulfil the knowledge gap and implementation of work, transferring and assigning experienced individuals to projects with priority in learning and maintaining project teams are the findings related to this section. Two additional subjects in the field of learning were added to the original research model. A total of 20 codes addressed the issue that dealing with learning only at the end of the project is not adequate, and the organization should consider this issue in stages during project implementation. In addition, the codes addressed the subject of promoting and employing existing tools to enhance learning.

3. **Supportive environment and culture**: A total of 68 codes were devoted to this section and all the four elements of the original model were confirmed. The findings led to the addition of "learning supportive structures" as one of the important parts of the learning support environment (Table 2).

Table 2
Codes associated with supportive environment and culture

Title	Number of codes
Supportive environment and culture	68
Learning Supportive Structures in a PBO	26
Psychological Safety	14
Openness to New Ideas	12
Time for Reflection	8
Appreciation of differences	8

The existence of matrix systems as supportive of job security and knowledge absorption in PBOs is a component of learning support structures. The management and accounting of intellectual capital at the organizational level, which is manifested in giving knowledgeable employees releasing and respect and welcoming their return, and in the need to recruit and retain qualified individuals, are also introduced in this section.

4. **Learning Facilitators**: A total of 48 codes indicated the presence of an independent body of concerned individuals, such as the project management office or project department to ensure that knowledge issues are dealt with and a quality system enhances the process. One of the challenges encountered in establishing such entities is assigning knowledge issues to custodians, who should have a facilitation and educational role rather than an executive one. Timely training aimed at promoting innovation can also facilitate learning in PBOs.

5. **Project Information Systems**: Findings from the case studies confirmed the role of empowering information systems aligned with the project life cycle. The presence of knowledge reservoirs, their availability, and attention to the role of support were among issues raised by the case studies. Falling prey to software solutions was among mistakes in the area of learning. The fact that software can be quickly launched and easily outsourced makes the organization deploy software prematurely. While, based on research findings, focusing on IT systems alone is not effective.

6. **Strategic Leadership**: Support by project and organizational managers for the learning system was reaffirmed as a key factor in this area. The awareness of project managers about learning, the authority of project managers and the need for them to hold their positions till the end of the project, and the alignment of project managers with the dynamic knowledge atmosphere of the project were also observed in the case studies. In addition, other managers were also committed to transferring experience in their work structure and to updating their experiences through participation in the project. The creation of practical requirements, in particular, contractual requirements for the implementation of learning, and constant monitoring and support by the leadership for the learning requirements were among other findings from the case study that were aligned with the initial model. Reflection on assigning and rearranging teams and support for learning and the alignment of knowledge between the employees and the project environment were identified as additional components of strategic leadership. Finally, the case studies concluded that the recognition of the

learning system implies that the system should be considered as a type of organizational evolution. This means that while accepting the cost and time required for the knowledge management and learning, the organization should support its employees, especially in the event of an error.

Table 3
Strategic leadership codes

Title	Number of codes
Strategic Leadership	63
Support by project and organizational managers	31
Practical requirements for the implementation of the learning process	14
Attention to internal capacity and the alignment of the employees with the dynamic atmosphere of the project	12
Attention to the learning system as an organizational change	6

7. **Incentive systems**: Most codes in this section highlight the value of learning in organizations. Such incentive systems were manifested in the organization's confidence in knowledgeable individuals, the dynamics of the learning system, the implementation of knowledge and the provision of feedback to individuals, and a lack of redline for the implementation of the learnings. Appealing incentive packages, including indirect financial rewards, manifested in cases such as the promotion of individuals on the basis of learning, the distinctness of knowledgeable individuals, and support for the presentation and transfer of knowledge by such individuals were also highlighted when investigating incentives. Avoiding actions that interfere with motivation such as project managers who oppose the use of experience from other projects or providing external education while knowledgeable individuals are available within the organization are among other issues in the field of motivation.
8. **Learning Processes**: The case study based on 130 codes resulted in the modification of the learning process of the initial research model as described in Fig. 6.

In the area of processes, the first step is to properly understand issues through a step-by-step review, followed by the correct identification of the problem. Apart from applying experience and knowledge to documents and advancing the project, the process of identifying experiences and knowledge also results in the compilation and development of knowledge maps and directs the individuals toward to knowledge repositories or knowledge sites throughout the organization. Evaluation and verification were generally conducted by specialized teams through follow-up meetings. The most important output of this process was the transfer of learning and the upgrade and control of project instructions, procedures, guidelines and project documents. The "Projection" approach is one of the pitfalls associated with information dissemination in the organization. This means that appropriate interaction is not established for the transfer and implementation of knowledge and experience despite the fact that sometimes excessive attention is being paid to learning. Once issues are evaluated and verified, it is necessary to ensure that they are observed, and reapplied through controlling and improving them.

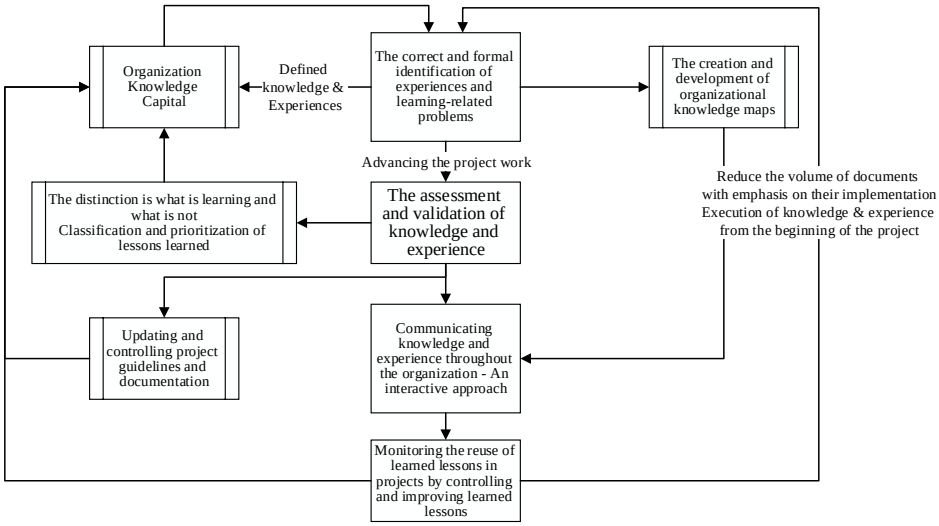

Fig. 6. Learning processes in the permanent division of the PBO

9. **Learning outcomes**: A total of 42 research codes were related to learning outcomes. The issue of improving project performance and avoiding the costs of rework and errors, as well as the low-cost delivery of projects. Empowering individuals, creating a sense of belonging, and helping to improve organizational productivity were also noted. Interviews suggested that through learning, PBOs would be able to fully utilize the knowledge generated by the project. A combination of these factors would lead not only to the survival but also to the further development and promotion of organizational activities.

9. Conclusion

Research has focused on different aspects of project learning. This article links various parts that are effective on learning in PBOs based on the Portuguese navigation system in the 15th century. By doing so, it achieves a comprehensive picture of PBLOs. In PBOs, emphasis is placed on delivering project achievements with regard to time, cost, and quality constraints. In a PBLO, the emphasis is placed on learning from the project environment so that learning is prioritized in all activities. In such organizations, leadership, structures, systems, processes, and platforms are joined to facilitate the learning and improvement of individuals, and to accelerate learning of the organizational level.

The PBLO is a living system concentrates on learning and improves its performance through it. PBOs are encouraged to pay attention to learning inputs if they intend to become learning organizations. This study introduces the promotion of understanding by the leadership and managers in the face of experience and learning as an important factor in supporting learning strategies. From this perspective, it is important for leaders and project managers to be involved in the learning system and also for managers to be committed to staying up to date and supporting learning.

Acceptance of investment in (not costs of) learning is a key element in the success of learning-related strategies in PBLOs. The introduction and separation of strategies in

the PBLO at the project and organizational level is among the findings of this study, which has led to the completion of previous studies. The results show that organizations pay more attention to in-project and inter-project learning mechanisms than other learning mechanisms, and it is necessary to consider issues such as learning in project boundaries as well as learning between parallel projects.

The mechanism for the systematic transfer of individuals with experience and knowledge from one project to another, as well as the allocation of knowledge agents throughout the project according to its knowledge needs, is one of the most important learning tools in the project space. Attention to the learning process at different phases of the project, not just at the end, is among other issues. Providing a detailed process in the permanent division of the organization and introducing an interactive approach as an alternative to the "Projection" approach are among important issues addressed in the research. The importance of absorbing lessons learned in project guidelines and documentation is another finding of this research, which is consistent with more recent research on project learning. By introducing learning outcomes, organizations can not only survive but also achieve a lot of competitive advantages.

The results of this paper have similarities to and differences from results obtained by other studies. The prominent role of organizational facilitators, including the Project Management Office, in building a knowledge bridge between the permanent and division of the organization and the temporary project, as well as the proper utilization of matrix systems (the link between permanent and temporary divisions) are among the findings of the study. The concept of "software trap" introduced by this article suggests that information technology is a means to an end, not the end itself. This concept emphasizes that there is no information technology can miraculously create a PBLO. The temporary nature of projects, as well as the priority of learning and experience transfer, highlight the need for incentive systems in PBOs, a finding that is in line with other research. This article specifically deals with the avoidance of "demotivational actions", an issue neglected by other research. This study is a step towards the development of a model of PBLOs.

The model can be further developed by providing assessment tools for PBLOs, the application of the model in other organizations, conducting quantitative studies to develop the different elements of the model, developing an incentive model in the project space, the detailed study of learning mechanisms at different levels, and the further evaluation of learning outcomes in PBLOs by examining the relationship between processes and outcomes.

References

Ajmal, M., Helo, P., & Kekäle, T. (2010). Critical factors for knowledge management in project business. *Journal of Knowledge Management, 14*(1), 156–168.

Ajmal, M. M., & Koskinen, K. U. (2008). Knowledge transfer in project-based organizations: An organizational culture perspective. *Project Management Journal, 39*(1), 7–15.

Anand, G., Ward, P. T., & Tatikonda, M. V. (2010). Role of explicit and tacit knowledge in Six Sigma projects: An empirical examination of differential project success. *Journal of Operations Management, 28*(4), 303–315.

Anantatmula, V. S., & Kanungo, S. (2010). Modeling enablers for successful KM implementation. *Journal of Knowledge Management, 14*(1), 100–113.

Bakker, R. M., Cambre´, B., Korlaar, L., & Raab, J. (2011). Managing the project

learning paradox: A set-theoretic approach toward project knowledge transfer. *International Journal of Project Management, 29*(5), 494–503.

Bartholomew, D. (2005). *Sharing Knowledge*. David Bartholomew Associates (DBA). Retrieved from http://www.usablebuildings.co.uk/Pages/Unprotected/SpreadingTheWord/SharingKnowledge.pdf

Bartsch, V., Ebers, M., & Maurer, I. (2013). Learning in project-based organizations: The role of project teams' social capital for overcoming barriers to learning. *International Journal of Project Management, 31*(2), 239–251.

Boh, W. F. (2007). Mechanisms for sharing knowledge in project-based organizations. *Information and Organization, 17*(1), 27–58.

Carrillo, P., Ruikar, K., & Fuller, P. (2013). When will we learn? Improving lessons learned practice in construction. *International Journal of Project Management, 31*(4), 567–578.

Chang, M. Y., Hung, Y. C., Yen, D. C., & Tseng, P. T. Y. (2009). The research on the critical success factors of knowledge management and classification framework project in the Executive Yuan of Taiwan Government. *Expert Systems with Applications, 36*(3), 5376–5386.

Choy, C. S., Yew, W. K., & Lin, B. (2006). Criteria for measuring KM performance outcomes in organisations. *Industrial Management & Data Systems, 106*(7), 917–936.

Cicmil, S. (2005). Reflection, participation and learning in project environments: A multiple. In P. Love, P. S. W. Fong, & Z. Irani (Eds.), *Management of Knowledge in Project Environments* (pp. 156–179). Oxford, UK: Butterworth-Heinemann.

Cooke-Davies, T. (2004). Project success. In P. W. G. Morris & J. K. Pinto (Eds.), The *Handbook of Managing Projects* (pp. 99–121). New Jersey: John Wiley & Sons, Inc.

Davidson, P., & Rowe, J. (2009). Systematising knowledge management in projects. *International Journal of Managing Projects in Business, 2*(4), 561–576.

Davis, D., & Daley, B. J. (2008). The learning organization and its dimensions as key factors in firms' performance. *Human Resource Development International, 11*(1), 51–66.

Dekoulou, P., & Trivellas, P. (2014). Learning organization in Greek Advertising and media industry: A way to face crisis and gain sustainable competitive advantage. *Procedia - Social and Behavioral Sciences, 148*, 338–347.

Dirani, K. M. (2009). Measuring the learning organization culture, organizational commitment and job satisfaction in the Lebanese banking sector. *Human Resource Development International, 12*(2), 189–208.

Disterer, G. (2002). Management of project knowledge and experiences. *Journal of Knowledge Management, 6*(5), 512–520.

Duffield, S., & Whitty, S. J. (2015). Developing a systemic lessons learned knowledge model for organisational learning through projects. *International Journal of Project Management, 33*(2), 311–324.

Ellinger, A. D., Ellinger, A. E., Yang, B., & Howton, S. W. (2002). The relationship between the learning organization concept and firms' financial performance: An empirical assessment. *Human Resource Development Quarterly, 13*(1), 5–22.

Farooq, O. (2012). Why are some firms more innovative than others? Exploring the role of learning organization components. *Global Business and Organizational Excellence, 31*(6), 42–49.

Figueiredo, P. N. (2002). Learning processes features and technological capability-accumulation: Explaining inter-firm differences. *Technovation, 22*(11), 685–698.

Garvin, D. A., Edmondson, A. C., & Gino, F. (2008). Is yours a learning organization? *Harvard Business Review, 86*(3), 109–116.

Gasik, S. (2011). A model of project knowledge management. *Project Management Journal, 42*(3), 23–44.

Hakamian, H., Sobhiyah, M. H., Aghdasi, M., & Shamizanjani, M. (2015). How can learning organization (LO) models can be used in an integration framework for project-based learning organizations (PBLO)? In *Proceedings of the 9th International Conference of Knowledge Management* (in Persian). Tehran, Iran.

Hanisch, B., Lindner, F., Mueller, A., & Wald, A. (2009). Knowledge management in project environments. *Journal of Knowledge Management, 13*(4), 148–160.

Hartmann, A., & Dorée, A. (2015). Learning between projects: More than sending messages in bottles. *International Journal of Project Management, 33*(2), 341–351.

Holzmann, V. (2013). A meta-analysis of brokering knowledge in project management. *International Journal of Project Management, 31*(1), 2–13.

Jafari, P., & Kalanaki, M. (2012). Relationship between the dimensions of learning organization and readiness-to-change. *Procedia - Social and Behavioral Sciences, 46*, 5811–5815.

Julian, J. (2008). How project management office leaders facilitate cross-project learning and continuous improvement. *Project Management Journal, 39*(1), 43–58.

Keegan, A., & Turner, J. R. (2001). Quantity versus quality in project-based learning practices. *Management Learning, 32*(1), 77–98.

Keikotlhaile, R., Ekambaram, A., Halvorsen, S., & Klakegg, O. (2015). Formalising the informal? – Finding a balance between formal teams and communities of practice in a project-based organisation. *Procedia - Social and Behavioral Sciences, 194*, 105–114.

Koskinen, K. U., & Pihlanto, P. (2008). *Knowledge management in project-based companies: An organic perspective*. Basingstoke, UK: Palgrave Macmillan.

Kotnour, T. (2000). Organizational learning practices in the project management environment. *International Journal of Quality and Reliability Management, 17*(4/5), 393–406.

Lampel, J., Scarbrough, H., & Macmillan, S. (2008). Managing through projects in knowledge-based environments: Special issue introduction by the guest editors. *Long Range Planning, 41*(1), 7–16.

Li, M., & Lu, X. (2007). Multidimensional learning organization and its impact on firm performance in Mainland China. In *Proceedings of the 2007 International Conference on Management Science and Engineering* (pp.1542–1547). IEEE.

Lierni, P. C., & Ribière, V. M. (2008). The relationship between improving the management of projects and the use of KM. *Vine, 38*(1), 133–146.

Lindkvist, L. (2004). Governing project-based firms: Promoting market-like processes within hierarchies. *Journal of Management and Governance, 8*(1), 3–25.

Lindner, F., & Wald, A. (2011). Success factors of knowledge management in temporary organizations. *International Journal of Project Management, 29*(7), 877–888.

Loufrani-Fedida, S., Missonier, S., & Saglietto, L. (2014). Knowledge management in project-based organizations: An investigation into mechanisms. *The Journal of Modern Project Management, 1*(3), 6–17.

Loufrani-Fedida, S., & Saglietto, L. (2016). Mechanisms for managing competencies in project-based organizations: An integrative multilevel analysis. *Long Range Planning, 49*(1), 72–89.

Love, P., Fong, P. S., & Irani, Z. (2005). *Management of knowledge in project environments*. Oxford, UK: Butterworth-Heinemann.

McHargue, S. K. (2003). Learning for performance in nonprofit organizations. *Advances in Developing Human Resources, 5*(2), 196–204.

Milton, N. (2010). *The lessons learned handbook: Practical approaches to learning from experience*. Oxford, UK: Chandos Publishing.

Paulin, D., & Suneson, K. (2011). Knowledge transfer, knowledge sharing and

knowledge barriers-three blurry terms in KM. *The Electronic Journal of Knowledge Management (EJKM), 10*(1), 82–92.

Pedler, M., Burgoyne, J., & Boydell, T. (1991). *The learning company: A strategy for sustainable development*. London, UK: McGraw-Hill.

Pemsel, S., & Müller, R. (2012). The governance of knowledge in project-based organizations. *International Journal of Project Management, 30*(8), 865–876.

Pemsel, S., & Wiewiora, A. (2013). Project management office a knowledge broker in project-based organisations. *International Journal of Project Management, 31*(1), 31–42.

Prencipe, A., Brady, T., Marshall, N., & Tell, F. (2005). Making sense of learning landscapes in project-based organisations. In P. Love, P. S. W. Fong, & Z. Irani (Eds.), *Management of Knowledge in Project Environments* (pp. 197–218). Oxford, UK: Butterworth-Heinemann.

Reich, B. H., Gemino, A., & Sauer, C. (2012). Knowledge management and project-based knowledge in it projects: A model and preliminary empirical results. *International Journal of Project Management, 30*(6), 663–674.

Reich, B. H., Gemino, A., & Sauer, C. (2014). How knowledge management impacts performance in projects: An empirical study. *International Journal of Project Management, 32*(4), 590–602.

Schindler, M., & Eppler, M. J. (2003). Harvesting project knowledge: A review of project learning methods and success factors. *International Journal of Project Management, 21*(3), 219–228.

Senge, P. M. (1991). *The fifth discipline: The art and practice of the learning organisation.* London, UK: Doubleday Currency.

Sense, A. J. (2008). Conceptions of learning and managing the flow of knowledge in the project-based environment. *International Journal of Managing Projects in Business, 1*(1), 33–48.

Sense, A. J. (2011). The project workplace for organizational learning development. *International Journal of Project Management, 29*(8), 986–993.

Shieh, C.-J. (2011). Study on the relations among the customer knowledge management, learning organization, and organizational performance. *The Service Industries Journal, 31*(5), 791–807.

Shokri-Ghasabeh, M., & Chileshe, N. (2014). Knowledge management: Barriers to capturing lessons learned from Australian construction contractor's perspective. *Construction Innovation: Information, Process, Management, 14*(1), 108–134.

Stothard, C., Talbot, S., Drobnjak, M., & Fischer, T. (2015). Using the DLOQ in a military context: Culture trumps strategy. *Advances in Developing Human Resources, 15*(2), 193–206.

Swan, J., Scarbrough, H., & Newell, S. (2010). Why don't (or do) organizations learn from projects? *Management Learning, 41*(3), 325–344.

Swart, J., & Harvey, P. (2011). Identifying knowledge boundaries: The case of networked projects. *Journal of Knowledge Management, 15*(5), 703–721.

Terzieva, M. (2014). Project knowledge management: How organizations learn from experience. *Procedia Technology, 16*, 1086–1095.

Turner, R., & Keegan, A. (2007). Managing technology: Innovation, learning and maturity. In P. W. G. Morris & J. K. Pinto (Eds.), *The Wiley Guide to Project Technology, Supply Chain & Procurement Management* (pp. 177–200). New Jersey: John Wiley & Sons, Inc.

Von Zedtwitz, M. (2002). Organizational learning through post–project reviews in R&D. *R&D Management, 32*(3), 255–268.

Wang, W.-T., & Ko, N.-Y. (2012). Knowledge sharing practices of project teams when

encountering changes in project scope: A contingency approach. *Journal of Information Science, 38*(5), 423–441.

Watkins, K. E., & Marsick, V. J. (2015). *Dimensions of the learning organization questionnaire*. Retrieved from http://www.lacrosseart.com/g3records/dloq.html

Watkins, K. E., & O'Neil, J. (2013). The dimensions of the learning organization questionnaire (the DLOQ): A nontechnical manual. *Advances in Developing Human Resources, 15*(2), 133–147.

Yoshimichi, A. (1995). *An examination of the SECI model in Nonaka's theory in terms of the TEAM linguistic framework*. Yamanashi Prefectural University, Japan. Retrieved from https://s3.amazonaws.com/academia.edu.documents/31512508/SECI-APPLY2.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1551521092&Signature=Y4BPeA2eFAbY5jRJYUcw86k5UCI%3D&response-content-disposition=inline%3B%20filename%3DSECI_APPLY2.pdf