Corporate Memory Processes in Project-Based Organizations: A Framework for Engineering Design Firms
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Abstract: Corporate Memory is associated with the organizational ability to register and retrieve previous knowledge with the purpose of supporting its current application and also decision-making. Within Project-Based Organizations (PBOs), the nature of Corporate Memory is influenced by the temporality, uniqueness and independence of their project portfolio. The research question has driven the investigation of how the memory capture, retention, recovery and application processes occur in PBOs. An empirical and qualitative study was carried out through a multiple case study conducted in three large Brazilian Engineering Design Firms which are organized by projects due to market demands. Document analysis, direct observation and semi structured interviews with engineers, project managers and executives were conducted. Data analysis has given evidences about the peculiarities of the processes that constitute the corporate memory cycle in PBOs. The memory capture process has taken place in five different forms: direct capture, indirect capture, capture by hiring professionals, experience capture and capture by knowledge transfer. Memory retention has crossed organizational boundaries and established a knowledge network of former employees and third parties. Memory application has emerged not only as a background to organizational learning and decision-making, but also as a platform for innovation and business advantage generation. It was also observed that the PBOs memory can be divided into volatile and perennial memory, where the former can be lost at the end or throughout project execution and the latter is internalized, becoming an inseparable part of the Corporate Memory. It was also found that there is a growing perception among the studied engineering firms that corporate memory is gradually shifting from a documentation burden required by the hiring companies and the Government towards a monetizable knowledge base. Surprisingly, lack of routines and project uniqueness were not considered as barriers to Corporate Memory, but as new knowledge generators. A detailed framework was proposed as a pathway to steer scholars, project managers, and engineers in the development of knowledge practices that promote enhanced Organizational Learning in transitory work contexts.

Keywords: Corporate Memory. Project-Based Organizations (PBOs). Organizational Learning (OL). Engineering Design Firms. Knowledge Management (KM)

1. Introduction
Corporate Memory is associated with the organizational ability to register and retrieve previous knowledge with the purpose of supporting its current application and also decision-making (Walsh and Ungson, 1991). Differently from traditional functional structures, Project-Based Organizations (PBOs) deal with their operations exclusively in a project-driven manner, and projects are their primary unit of production, innovation and competition (Hobday, 2000).

When a PBO is not capable of applying previous knowledge of its Corporate Memory or when there are problems in building or retrieving knowledge from such memory, losses may happen due to mistaken decisions or to the reinvention of solutions applied in previous projects (Oti, Tah and Abanda, 2018). When compared to other types of more permanent organizational structures, the nature of Corporate Memory in Project-Based Organizations (PBOs) is particularly influenced by the temporality, uniqueness and independence of their project portfolio.

Previous studies that relate Corporate Memory to PBOs may be highlighted. Lindner and Wald (2011) emphasized the lack of mechanisms for capturing, storing and disseminating Corporate Memory. Additionally, Kasvi, Vartiainen and Hailikari (2003) applied Corporate and Project Memory concepts to study Knowledge Management (KM) and skill development in project environments. Ghosh, Amaya and Skibniewski (2012)
stated that the relationship between project knowledge and institutionalized knowledge is a gap to be explored, since the connections between Corporate Memory and Project Memory should be better understood. Lopes et al. (2015) pointed the need for studies to explain the low rates of practices replication from PBOs knowledge bases. Although these studies presented important elements that link Corporate Memory to projects, none of them proposed an integrated model that explains how the PBOs capture, store and retrieve knowledge for later application.

The paper objective is to analyze the occurrence of memory capture, retention, recovery and application processes in PBOs. An empirical and qualitative study was carried out through a multiple case study conducted in three large Brazilian Engineering Design Firms which are organized by projects due to market demands. Besides this introduction, the paper is structured as follows: Section 2 comprises the background about Corporate Memory and its retention mechanisms, the technologies associated with project memory systems and the particularities of the PBO context; Section 3 details the research methodology which involved document analysis, direct observation and semi structured interviews with engineers, project managers and executives were conducted; Section 4 presents and analyzes the research results, proposing a Corporate Memory Framework for the context of PBOs which is the major theoretical contribution of this study; Section 5 concludes the paper by discussing its implications for further studies and limitations.

2. Theoretical Background

Corporate Memory is considered as an organizational entity that has its origins in individual memory (Estevão and Strauhs, 2015). Nevertheless, the extension of a human concept to the firm level has many ambiguities whilst considering similar characteristics. Corporate Memory is defined a set of historical information stored by the organization for possible future decision-making (Walsh and Ungson, 1991). Furthermore, the preservation of applied models, organizational changes and learned lessons may avoid future mistakes (Estevão and Strauhs, 2015).

2.1. Corporate Memory Retention Structures

Retention structures have the purpose of build information repositories, preserving organizational knowledge (Walsh and Ungson, 1991). The major retention mechanisms are individuals, culture, transformations, structures, ecology and external files (Casey and Olivera, 2011), which are explained next.

Individuals keep memories of organizational events through their direct experiences and observations (Walsh and Ungson, 1991). Culture is understood as a means of sharing collective perceptions, thoughts and feelings, retaining past experiences (Lehner and Mayer, 2000). The transformation mechanism retains information through standardized processes, routines or self-fulfilling prognoses arising from changes (Casey and Olivera, 2011). The organizational structure contains functions and individual roles, providing an information repository that influences decision-making paths (Lehner and Mayer, 2000). Ecology refers to the physical structure of the work environment, such as the office layout or even the furniture style, which reflect the firm hierarchy and status. External files consist of a repository located beyond the organizational borders which retain relevant information (Walsh and Ungson, 1991).

Complementary retention structures were proposed after the studies of Walsh and Ungson (1991). Information space is defined as a mean of storing unstructured information such as memos, files, forms, agendas, drawings and photos (Karsten, 1999). Relationship memory focus on the connections between firms (Selnes and Sallis, 2003), creating an interface culture (Anderson, 2010). Figure 1 represents the Corporate Memory retention structures.
2.2. Corporate Memory Systems and Project Memory

Corporate Memory systems are considered a specific type of KM systems that provide a set of tools for knowledge retention, enabling users a quick and structured access to organizational experiences (Reátegui et al., 2015). Such systems should be not considered as a synonym for KM systems, since Corporate Memory systems focus on knowledge susceptible for reuse (Basaruddin, Haron, and Noordin, 2011).

The Project Memory consists of a simplification of the Corporate Memory, presenting a reduced scope. It is responsible for storing all knowledge related to the project, its activities and its history. It is considered as one of the most common types of memory found in organizations, together with Corporate Memory, Business (or Technical) Memory and Individual Memory (Bascans et al., 2016). The formation of the Project Memory takes into account aspects such as the organization of the project itself, the rules and methods used for its development, the resolution of potential problems, the methods of evaluating possible solutions, as well as the decision-making process (Nada et al., 2015). Project Memory systems are designed to capture knowledge from project documentation, taking into account the context and the social processes (Lindner and Wald, 2011; Barros, Ramos, and Perez, 2015). Such systems usually emphasize learned lessons in order to apply past project knowledge into new projects (Oti, Tah, and Abanda, 2018).

2.3. Corporate Memory in Project-Based Organizations (PBOs)

Temporality strongly acts on the project knowledge capture, since the execution processes are interrupted at the end of the project (Chronéer and Backlund, 2015). Temporality also results in less time being spent on knowledge-sharing activities in projects, because the main drive is to meet the iron triangle (scope, cost and time) criteria (Mueller, 2015).

In addition to the intrinsic temporality of the projects, the PBOs also suffer from the temporality of the teams, since they are often dispersed at the end of project, inhibiting the formation of routines and the development of trust relationships, which facilitate knowledge sharing (Kitimbo and Dalkir, 2013). The short-term nature of the relationships between project members challenges the retention and future use of knowledge (Cattani et al., 2011). Furthermore, the PBOs structures consist of considerably independent project teams (Hobday, 2000), generating a detachment between the project and the organization.

3. Research Methodology

A qualitative approach was applied to interpret Corporate Memory processes and consider contextual features (Yin, 2016). An empirical study was carried out through a multiple case study conducted in three large Brazilian Engineering Design Firms, enhancing construct understanding by inter case analyses (Ridder, Hoon, and McCandless, 2009).

The Brazilian companies were referred as Alpha, Beta and Gamma to keep the confidentiality. The companies develop projects for the mining, metallurgical, fertilizer, energy, cellulose, manufacturing, cement, oil and gas industries. Alpha Engineering was founded in 1960, has 250 employees and units in 4 Brazilian states: Minas Gerais, Espírito Santo, São Paulo and Rio de Janeiro. Founded in 1970, Beta Engineering has 1,200 employees
and 6 units in 3 Brazilian states: Minas Gerais, Espírito Santo and Rio de Janeiro. Gamma Engineering is the younger and smaller company in this research sample. It was created in 2014 and has 50 employees.

In order to provide data triangulation (Yin, 2016), document analysis, direct observation and semi-structured interviews with engineers, project managers and executives were conducted. Pretests were done to validate the semi-structured interview script. A planned selection of the interviewees who have key roles was done to contemplate complementary views of the Corporate Memory processes, resulting in nine interviews (Table 1).

Table 1: Interviewees Profile

<table>
<thead>
<tr>
<th>Engineering Design Firms</th>
<th>Current Position</th>
<th>Time in the Firm</th>
<th>Experience Time with PBOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>Planning Manager</td>
<td>6 years</td>
<td>12 years</td>
</tr>
<tr>
<td>Alpha</td>
<td>Engineering Director</td>
<td>26 years</td>
<td>26 years</td>
</tr>
<tr>
<td>Alpha</td>
<td>Project Manager</td>
<td>18 years</td>
<td>40 years</td>
</tr>
<tr>
<td>Beta</td>
<td>Project Manager</td>
<td>1 year and 2 months</td>
<td>11 years</td>
</tr>
<tr>
<td>Beta</td>
<td>Engineering Director</td>
<td>4,5 years</td>
<td>15 years</td>
</tr>
<tr>
<td>Gamma</td>
<td>Contract Manager</td>
<td>8 years</td>
<td>14 years</td>
</tr>
<tr>
<td>Gamma</td>
<td>Engineering Manager</td>
<td>8 months</td>
<td>30 years</td>
</tr>
<tr>
<td>Gamma</td>
<td>Administrative Director</td>
<td>4 years</td>
<td>40 years</td>
</tr>
<tr>
<td>Gamma</td>
<td>Planning Coordinator</td>
<td>2 years</td>
<td>7 years</td>
</tr>
<tr>
<td>Average Time</td>
<td></td>
<td>7,8 years</td>
<td>21,6 years</td>
</tr>
</tbody>
</table>

The interviews were recorded and transcribed and processed together, resulting in seven hours and five minutes, with an average of approximately 47 minutes per interviewee. The transcription of the interviews generated 104 pages. The collection of documents included commercial dossiers containing administrative information, market information, applied technologies, certifications and service portfolios. Internal documents were also used, such as organizational charts, quality procedures, manuals, as well as information obtained from engineering firms’ websites. Direct observation was carried out through visits to companies in order to learn about work processes and daily routines.

An in-depth separated analysis of each case comprised document reading and content analysis (Bardin, 2009), associating the content with the theoretical categories (Table 2). Later, a cross-case analysis was performed to identify similarities and differences among the cases. A framework was proposed to represent the processes of Corporate Memory capture, retention, retrieval and application in the context of PBOs.

Table 2: Theoretical Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Subcategories</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process</td>
<td>Explicit knowledge capture</td>
<td>Walsh and Ungson (1991); Conklin (2001); Perdigão et al. (2015)</td>
</tr>
<tr>
<td></td>
<td>Tacit knowledge capture</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Explicit knowledge retention</td>
<td>Walsh and Ungson (1991); Anderson (2010)</td>
</tr>
<tr>
<td></td>
<td>Tacit knowledge retention</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Explicit knowledge retrieval</td>
<td>Walsh and Ungson (1991)</td>
</tr>
<tr>
<td></td>
<td>Tacit knowledge retrieval</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Knowledge application</td>
<td>Walsh and Ungson (1991); Estevão and Strauhs (2015)</td>
</tr>
<tr>
<td>Knowledge Bases</td>
<td>Information volume</td>
<td>Nascimento et al. (2016)</td>
</tr>
<tr>
<td></td>
<td>Types of bases</td>
<td>Martin and Diván (2016)</td>
</tr>
<tr>
<td>Retention Structures</td>
<td>Individuals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Culture</td>
<td>Walsh and Ungson (1991)</td>
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<tr>
<td></td>
<td>Transformations</td>
<td></td>
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<tr>
<td></td>
<td>Organizational structure</td>
<td></td>
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<tr>
<td></td>
<td>Physical structure (Ecology)</td>
<td></td>
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<tr>
<td></td>
<td>External files</td>
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</table>
4. Data Analysis

Corporate Memory is not a familiar concept to the three Brazilian Engineering Design firms, although their routines embedded many initiatives towards registering knowledge to avoid the same mistakes of the past and to support decision making. Corporate Memory practices are better understood through a closer view of its processes: capture, retention, retrieval and application.

4.1. Memory Capture

The knowledge capture within the scope of the PBOs can be split into two specific sets: one related to Records Management (explicit knowledge), such as technical drawings and project documents, and the other associated with individuals (tacit knowledge). The explicit capture may occur directly while filing a document that contains useful knowledge, or indirectly, while updating the knowledge base after some relevant project occurrences.

The explicit direct capture is usually motivated by a compulsory routine, as said by the Planning manager of the Alpha firm: “[...] even if our company does not want to document, the customer requires a great level of project control, documenting reviews and deliveries, so we are obliged to document.” Additionally, documentation is legally required not only from public authorities, but also for the maintenance of quality certificates, such as ISO 9001, that enable participation in project bids. On the other hand, the explicit indirect capture is a voluntary process that is part of the Engineering firms culture when insights for quality or performance improvements are perceived during project execution as the testimony of the Engineering manager of Gamma firm: “we have a standard, but it is changed when we see better approaches. We try to use the same criteria of the projects with better results.”

The tacit knowledge capture is less systematic and was found in three different manners in the investigated companies. The acquisition capture is related to specialists hiring for projects and it is bounded by high turnover. According to the interviewees, when an individual leaves the Engineering Design firm, none or little residual knowledge is absorbed by the organization, characterizing memory loss. In some situations, the organization needs to get in touch with ex-employees in a desperate knowledge rescue, as said by the Engineering direct of the Alpha Firm: “some ex-employees are seniors with high expertise, acting as living memories for us, but at some point, this approach will no longer work”. The second manner of tacit knowledge capture was called knowledge transfer capture and comprises knowledge obtained from third parties such as consultants and instructors. The third manner is experience capture and its origin is practical experimentation during project execution.

4.2. Memory Retention

The occurrence of Corporate Memory retention practices were classified according to retention mechanisms (Casey and Olivera, 2011) and Figure 2 shows how many interviewees recognize such mechanisms in their companies.
There were evidences of organizational actions to promote better knowledge diffusion among employees and also ex-employees. Organizational structure also reinforce the need to preserve project memory, as reported by the Planning manager of the Alpha firm: “roles define the way the information flows inside our company.” Internal archives were recognized as the major structure for explicit knowledge retention by all respondents. Negotiation outcomes keep not only the well-succeed parameters that serve as reference data and constraints to project execution, but also the failures that are considered input to learned lessons. Organizational culture was perceived as way to retain the corporate values and create bonds with a temporary workforce. Direct observation showed that the physical structure of the workplace, which was called ecology (Casey and Olivera, 2011), promotes knowledge sharing, since there are no physical barriers between departments and different engineering specialties, and there is easy access to the top management. Transformation and external files were the retention structures less perceived by the respondents.

4.3. Memory Retrieval

Corporate Memory retrieval is based upon Records Management or tacit knowledge. In the explicit case, despite project documentation, the retrieval of other types of documents is very dependent of the department in charge, presenting a wide range of variation of file control systems and mixture of physical and digital archiving techniques. Project documentation follows more standardized procedures among Engineering Design Firms in order to retrieve past projects solutions. According to the interviewees, the most common search methods for project documentation are the document list (metafile that contains all types of project documents), metadata provided by ECM (Enterprise Content Management software) or keyword search. Despite the standardization efforts, the interviewees of Gamma firm reported that the document list usage is still dependent of individual memory to remember which solution was applied in each project. The usage of ECM and keyword search is more flexible on Alpha and Beta firms, but the information overload and the lack of patience of engineers to try different search criteria lead to indifference, as outlined by the Project manager of Beta firm: “unfortunately, we prefer to start from scratch in our way than to try to locate something that was previously done.”

Tacit knowledge retrieval consists of direct access to the professionals with no predefined process. It is totally dependent of the individual memory and is considered as “undocumented learned lessons rescue” (Contract manager of Gamma firm). This rescue operation also extends to ex-employees as largely commented by the respondents.

4.4. Application Process

Corporate Memory application processes is guided by the different needs of project execution and “it is not ruled by previous routines” (Project Manager of the Beta firm). One of the frequent memory application process is the development of new engineering solutions for project problems. Besides its contribution for organizational learning and decision-making, the usage of Corporate Memory was also perceived as a way of
carrying out more assertive projects in a short time, seeking past experiences and adapting them in new contexts. Another application of Corporate Memory was related to commercial processes, allowing engineering firms to develop more precise technical and commercial proposals based on past contract models.

“Whenever we are going to develop a new project, we seek within our network something that has been accomplished in a similar way to the next project, so we can rescue not only the knowledge, but also the sources, the suppliers and the contractors who worked with us” (Engineering Manager – Gamma firm).

Learned lessons were also recognized as an application process of Corporate Memory, although only Alpha and Beta firms conduct it formally. Nonetheless, two major difficulties were found in the learned lesson approach. The first issue is about lesson registering, as highlighted by the Project manager of Beta firm: “you need to know how to register a lesson, because sometimes we found not very clear lessons. In some lessons, you would need to have lived this past situation to understand what is about.” The second issue is about lessons retrieval, since there are no routines that promote the search for past experience.

4.5. Framework for Corporate Memory in Project-Based Organizations (PBOs)

Compiling evidences from multiple case studies, a framework for Corporate Memory is then proposed, representing how PBOs capture, retain, retrieve and apply knowledge (Figure 3).

As proposed in the framework, explicit knowledge captured from the records may happen in a direct manner (document archiving) or in an indirect way, such as the modification of a project pattern. Tacit knowledge capture may occur by acquiring specialists, transferring external knowledge to the fixed team (employees) or...
experience acquisition. Such knowledge flows may have two different destinations: Corporate Memory or Project Memory, which was divided into volatile and perennial memory (Figure 4).

**Figure 4: Relation between Corporate Memory and Project Memory**

The volatile project memory is considered as a short-term memory that may or may not be internalized by the organization. Such memory is more influenced by the temporary characteristics of the projects, the permanence level of the team members and also how physically close or distant they are, as well as the work at a distance. On the other hand, the perennial project memory is a long-term memory, which lasts beyond the end of the project. This memory should not be interpreted as a separate entity, but as a component of the Corporate Memory.

The knowledge that was captured from the fixed teams (employees) and the organizational records are directed straightforwardly to the Corporate Memory. The formal records of the projects (basically drawings and documents) are directed to the perennial project memory, being available to the project members and the whole organization, since there is usually a common repository. In contrast, the knowledge derived from informal records and temporary staff is retained in the volatile project memory. Indeed, a formal transfer process from volatile memory to perennial memory is highly recommended to avoid knowledge loss.

The proposed framework has some limitations, since it is fair to recognize that knowledge is not preserved only through internal Corporate Memory. The research evidences highlighted the existence of knowledge outside the boundaries of Engineering Design firms and this phenomenon may be called as External Memory Expansion. This expansion comprises the informal knowledge network of third-party professionals or former employees of the organization. Inquiries to this network are part of the daily routine of the Engineering Design firms due to the high turnover and the limited presence of experts in the projects.

The proposed framework considers two important variables. The first one is related to the knowledge source: technical or administrative. The specialized technical knowledge is more influenced by the project intrinsic characteristics, such as temporality, turnover and the need for formal records. The second variable is associated with the knowledge form: tacit or explicit. The combination of these two variables (knowledge source and form) results in four different memory retrieval categories, as shown in Figure 3: (i) Retrieval from department files and records of lessons learned; (ii) Retrieval from employees' memory; (iii) Retrieval from controlled technical files; and (iv) Inquiries to specialists, outsourced consultants and a network of former employees.

The retrieved memories may be used for two main purposes in the Engineering Design firms: project application or organizational application. The retrieved knowledge may be applied in the same project or in later projects, and such applications are usually associated with the development of technical engineering solutions or project performance improvement by reducing rework. Oppositely, organizational applications are more diverse, more comprehensive and encompass decision-making and organizational learning. In addition, organizational application examples comprise the development of commercial advantages, new expertise, and also product and process innovation.

5. **Conclusion**

The Corporate Memory processes in PBOs are subject to several peculiarities of the project environment. The proposed Corporate Memory framework is considered the main theoretical contribution of this study (Figure 3). Five forms of memory capture are represented in the framework: direct, indirect, acquisition, experience and transfer. Two different retention structures were identified for the project memory: the volatile short-term memory and the perennial memory, which is a component of the Corporate Memory. The existence of an
External Expansion of Corporate Memory was evidenced, emphasizing the role of a knowledge network that is beyond the organizational borders. The framework also represents the different forms of memory retrieval and application.

The contributions to project practitioners deal with some actions to promote tacit knowledge sharing in order to mitigate the effects of turnover and temporality. Better team training, modern office layouts, diversified team composition, meetings focused on learned lessons are initiatives that may foster knowledge sharing. Knowledge maps would be useful to document the connections of the internal and the external social network (consultants, former employees, suppliers, contractors). Knowledge maps would also help the expertise location for specific projects and the identification of knowledge gaps, providing insights for training and development. Considering explicit project knowledge, one recommendation to practitioners is the organization of knowledge bases not exclusively by projects (each project is a different folder), but also by knowledge types. The usage of metadata and new layers of classification will result in better project search.

A limitation of this study is that the framework was designed to represent Corporate Memory processes of Project-Based Organizations and its generalization to other types of organizations was not investigated. Furthermore, this study analyzed three large Brazilian Engineering Design firms as examples of PBOs and the memory processes may vary in PBOs of different industries and countries. Although the interviews were conducted with key project professionals of the three companies and multiple sources were used for data triangulation, different perception would arise in a survey in the same companies.

Consequently, future studies should be suggested. Considering that Brazilians are usually very social and favor tacit knowledge, the adaptation of the framework in organizations or cultures that are more formal and process-driven would be interesting. Furthermore, the framework validation in PBOs of other industries would be relevant since this study has given evidences that knowledge is quite sensitive to the project contexts.

Finally, Corporate Memory should be considered not only as a way to capture and apply knowledge, but the organizational identity of Project-Based Organizations, since it is the entity that survives from the project temporality, molding PBOs values and culture. Indeed, memories define who we are.

References


