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WEB-BASED KNOWLEDGE MANAGEMENT SYSTEMS: A FIELD STUDY OF *"MORN"* IN R&D PROJECT MANAGEMENT

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ABSTRACT

Current researches in organizational theory attempt to reveal how information technology and especially organizational memory systems can support organizations. Unfortunately, the research on this area especially barriers to an effective organizational memory system, stayed limited. Moreover, an empirical inquiry on how organizational memory barriers can be beaten by Web-based systems, really, remained an uncharted area.

So far, the impacts of cultural and technical barriers on organizational memory systems have received, to our knowledge, no attention in Turkey. Besides, in Turkey, empirical studies combining distributed partners in a concurrent project management setting are insufficient. As a matter of fact, none systematic work in electronic media has been done in Turkish Land Forces. Despite very limited theoretical infrastructure, this area seemed as a ripe topic for exploration.

To contribute to the body of knowledge, it is attempted to integrate literature sources with our theories and strove to transform theoretical concepts into practical operations. The field study of MORN (Multimedia Object Relation Network), one of the web-based knowledge management and organizational memory systems, is presented. Methodology focused on the *"process"* and *"product"* analysis by view of management, and the exploration of practical thoughts. Paying special attention to the roles it can play in enhancing organizational memory and in overcoming barriers, the perceived usefulness of MORN in concurrent R&D project management have been focused. Improvements on project managers' core competencies, usability of MORN and probable contributions to organizational memory, have been discussed in terms of "*People-System-Organization approach"*.

With the data supplied by this study (and future ones), it is assumed that organizational memory of Turkish Land Forces and similar organizations, with a recent but growing interest will be effectively developed.

Keywords: Knowledge Management, Organizational Memory, Web-based Project Management, Virtual Team, MORN, GDPM, Tacit Knowledge, Explicit Knowledge

INTRODUCTION

As the *"computer age"* continues to give way to the *"information age",* there is no doubt that organizations which effectively gather, monitor, and filter information will be one step ahead their competitors. Clearly, only the civilizations that can produce and manage the knowledge are going to survive. For this reason, knowledge management has become an important discipline. One of the major characteristics of the information age order is that technology

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is continually being developed that increase our ability to collect, synthesize, organize, monitor, and disseminate knowledge. Besides, the use of this technology will dramatically alter the ways knowledge sharing takes place in organizations. Technology advances of past decade have provided an ever-increasing array of tools to assist group decision-making, generating and preserving significant amount of knowledge, capturing organizational memory and managing virtual teams.

Many studies in the literature would like to find ways that information technology and especially organizational memory systems can support organizations (Abecker, et.al, 1998: 40-48; Borghoff and Pareschi, 1999: 14; Murray, 1999a; Liao, et.al, 1999). In our consideration, to achieve this, obstacles resist to organizational memory should be perceived deeply. The research on this area began to attract attention after the midway of 1990s (Conklin, 1996a: 561-565). As many researchers emphasized, web-based management information systems seem to support both organizational memory and distributed projects by means of their flexible technology (Dennis, 1996; Appelt, 1996). But, an empirical inquiry on how organizational memory barriers can be beaten by web-based systems, really, remained an uncharted area.

So far, the impacts of cultural and technical barriers on organizational memory systems have received, in our consideration, no attention in Turkey. Besides, in Turkey, empirical studies combining distributed partners in a concurrent project management environment are very insufficient. The need for detailed studies to explore these topics is even more imperative than many other organizational concepts.

Turkish Land Forces with its structure, budget, the amount of personnel and geographically dispersed units in various locations around the world is a gigantic organization, in which several projects are being performed concurrently. It is obvious that knowledge management have crucial importance in concurrent project management. This reveals the importance and priority of capturing organizational memory throughout Turkish Land Forces. The reason for this is twofold.

First, people, especially members of military R&D projects, have difficulty in finding the information they need, often because an assortment of inconsistent tools has been presented to access documents.

Second, more importantly, a standard connotation of organizational memory is dominant throughout Turkish Land Forces. In other words, materials in written record, documents in the databases or in filing systems are perceived the single sources of organizational memory. Namely, explicit (formal) knowledge such as numbers, facts, graphics and rules, is accepted as organizational memory. But, as our study revealed, individuals are prime locations for

retention of the organization's knowledge. Tacit knowledge such as expertise, experiences, anecdotes, incidents, and details about practices, decisions and procedures are neglected, poorly preserved and managed. What is needed in the army are ways to store and retrieve the second type of knowledge.

Up to date, it is a known fact that, none systematic work in electronic media has been done on these topics in army. Despite very finite theoretical infrastructure, it is an area (especially barriers to organizational memory and web-based project management) that is ripe for exploration.

To add to the existing limited knowledge in the literature, a field study of MORN in concurrent R&D project management was undertaken. By systematic thoughts, this research aims to convert theoretical concepts into practical operations and the methodology focuses on the process analysis from management viewpoint, and the exploration of practical thoughts.

It is now an accepted view that the utilization of such systems can only be assessed in natural situations (Ackerman and Halverson, 1998: 24). Therefore, the research project (here called *“MORN Project”)* involving different people with various roles, competencies, and backgrounds in various locations has been explored. The distribution was both intellectual and geographical. Sub-projects aimed to explore urgent topics relevant to processes in Turkish Land Forces and the participants included current military individuals from different locations of Turkey. Furthermore, all members of the virtual team have played the developer role in the requirement analysis of MORN.

Paying special attention to the roles it can play in enhancing organizational memory and in overcoming organizational memory barriers, the perceived usefulness of MORN in concurrent R&D project management have been focused over 5 months. Variables were neither controlled nor manipulated, and no artificial setting was created for the study. Improvements on project managers’ core competencies, usability of MORN and probable contributions to organizational memory, have been discussed in terms of *“People-System-Organization approach”.*

The research used numerous data collection procedures including initial, mid and final questionnaires, critical incident interviews, and field observations. All the participants of the virtual team played a *“developer role”* at the requirement stage of the design process of MORN. In one sense, the virtual team was the *"prosumer"* (producer and consumer) of its knowledge.

The study was *"descriptive",* and” we have only scratched the surface of an area which is believed to be useful for further researches. In one sense, because of the design efforts of the software, the research can be labeled as *“pre-descriptive”.*

The purposes of this study were primarily twofold in nature. The first main goal was to develop and to improve a web-based distributed multimedia information system as a practice of capturing organizational memory. The second one was, as an implementation of virtual teaming, to manage geographically distributed R&D projects concurrently using MORN software.

It can be concluded that the organizational memory obstacles described in the literature conform to our findings to some extent.

There is no doubt that the results fruited a foresight about the utilization of such systems in Turkish Land Forces. With the facts provided by this research (and future ones), it is supposed that organizational memory of Turkish Land Forces and similar organizations, with a recent but increasing interest will be efficiently developed.

1. LITERATURE REVIEW

1.1. KNOWLEDGE MANAGEMENT

As emphasized by Skyrme (1997: 14), knowledge has emerged as a current hot topic for many organizations. Many see knowledge management as the next source of competitive advantage (Choo, 1996: 329-340; Malhotra, 1998. 58-60; Davenport, 1999: 9).

While Farquhar (1995: 4) argues that it is the distinction between information and knowledge that makes the difference, Murray (1999b) indicates that describing the difference between information and knowledge is difficult because both are pervasive and because the terms are often used interchangeably. Newman (1996) summarizes knowledge as the full utilization of information and data, coupled with the potential of people's skills, competencies, ideas, intuitions, commitments and motivations. From a historical view, knowledge is the next paradigm shift in computing following data processing (1945-1965) and information management (1966-1995). Under this view, knowledge can be defined as an action, focused innovation, pooled expertise, special relationships, alliances, and value-added behaviors and activities.

1.1.1. Two Kinds of Knowledge: Tacit and Explicit

While Sveiby (1997) emphasizes that in each activity, there are two different levels or dimensions of knowledge, which are mutually exclusive and complementary. Nonaka and Takeuchi (1995: 45) state these dimensions in different terms. They emphasize the difference between explicit knowledge which can be articulated in formal language and transmitted among individuals, and tacit knowledge, personal knowledge embedded in individual experience and involving such intangible factors as personal belief,

perspective, and values. In fact, it is accepted in the literature that the distinction originally made by Polanyi in 1966 (Nonaka and Takeuchi, 1995: 44; Sveiby, 1997). Borghoff and Pareschi (1999: 14) express the same idea in a similar way; explicit knowledge is formal knowledge that can be packaged as information and can be found in the documents of an organization: reports, articles, manuals, patents, pictures, images, video, sound, software etc. Tacit knowledge is personal knowledge embedded in individual experience and is shared and exchanged through direct contact. Thus, it needs working together for a period of time.

As generally accepted in the literature, these two types of knowledge are like two sides of the same coin, and are equally relevant for the overall knowledge of an organization. Indeed, the other great discovery of the knowledge movement lies in the following simple observation: knowledge which does not flow, does not grow and eventually ages and becomes obsolete and useless - just as money which is saved without being invested eventually loses value until it becomes worthless (Borghoff and Pareschi, 1999: 15-16).

1.1.2. The Need for Knowledge Management

Knowledge is the result of learning that provides the only sustainable competitive advantage. Thus, it is argued that knowledge should not be just information or just data! More importantly, as Nonaka and Takeuchi (1995: 44-45) presented, the synergistic relationship between tacit and explicit knowledge in the organization, must be considered deeply. Organizations need to become skilled at converting personal tacit knowledge into explicit knowledge that can push innovation as a source of competitive advantage.

It is a known fact that knowledge management is more than a necessity for organizations like Turkish Land Forces, whose principal resource is knowledge rather than physical and financial resources. Actually, knowledge management is a contraversary issue in Turkish Land Forces, because those widely used classical knowledge management tools such as standard operating procedures (SOPs), concept of master-apprentice, hand-over documents are not so effective in serving this purpose.

1.1.3. Information Technology for Knowledge Management

Knowledge management is a combination of various technologies such as artificial intelligence, knowledge-base systems, Internet, Intranet, web, information retrieval technology, electronic publishing technology, hypertext/hypermedia, decision support systems, database technologies, help desk technology, expert systems, geographic information systems, performance support systems, computer-supported collaborative work (groupware), simulation and brainstorming applications (Murray, 1999a). Ultimately, many of these technologies need to be integrated under the

umbrella of a formal strategy that transcends short-term technical requirements and vendor-specific models for information resources. This strategy must be shaped by the organizational culture itself. Interchange standards, models for knowledge resources, and standards for measuring the value of knowledge work will be keys in this effort.

1.2. ORGANIZATIONAL MEMORY

The recognition that knowledge is one of an organization's most important assets has fueled interest in comprehensive approaches to the basic activities of knowledge management: the identification, acquisition, development, dissemination, use, and preservation of the organization's knowledge. An organizational memory must be more than an information system but must also help to transform information into action. Organizational memory is therefore intrinsically linked with organizational learning (OL) and serves as a potential source of OL. In their recent article, Abecker et.al, (1998: 40-48) argue that their long-term vision is an OM at the core of a learning organization, supporting, sharing and reuse of individual and corporate knowledge and lessons learned. As shown in figure 1, they summarize this phenomenon as; "...*Arranged around such an OM, intelligent knowledge management services actively provide the user working on a knowledge-intensive operational task with all the information necessary and useful for fulfilling this task*..."

There are significant technical and cultural barriers to capturing tacit knowledge and making it explicit. Some tools tend to make informal knowledge explicit, but they generally fail to create a coherent organizational memory.

While Conklin (1996a: 561-566) argues that contemporary organizations have only a weak ability to remember and learn from the past, and are thus seeking to gain the capacity for organizational memory, Ackerman (1998: 203-205) states that a recent but growing interest for organizations and groups has been to augment and manage their knowledge and expertise.

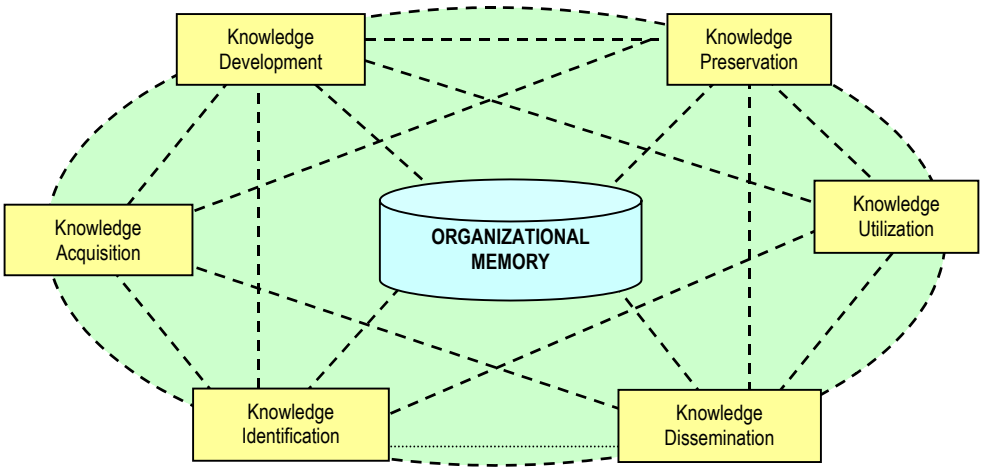

Figure 1: OM assists in the basic knowledge management activities (Abecker et.al, 1998)

1.2.1. Knowledge and Learning Organizations

A knowledge organization is one in which the key asset is knowledge. Its competitive advantage comes from having and effectively using knowledge (Conklin, 1996b: 21-22). Organizational memory is perhaps most clearly missing in industries where large numbers of people engage in the design and construction of large, complex systems over long periods of time (Conklin, 1996a: 562).

Learning organizations are characterized by actively supporting learning processes of their members and continuous self-development. The objective of the learning organization is to recognize and perform necessary change processes itself. Certainly, this institutionalized learning and adaptation culture assumes a *"learning culture"* which fosters innovations and creativity (Senge, 1990: 76). Paper and Johnson (1996: 20-33) as well as Nevis, et al. (1995: 73-85) emphasize that OL includes personal learning of single members of an organization but goes beyond it. Therefore, OL is more than the sum of individual learning results. Nevertheless the question arises where learning organizations actually retain their knowledge. *"... For organizational learning occur, learning agents' discoveries, inventions, and evaluations must be embedded in organizational memory*" (Argyris and Schon, 1978: 51-52). Thus, organizational memory is the result of OL if the learning is captured and there is an ability to share the resulting knowledge (Ackerman, 1998: 203-209).

1.2.2. Characteristics of Organizational Memory

Walsh and Ungston (1991: 57-91) discuss that organizational memory can be retained in six places: individuals, organizational culture, organizational transformations, organizational structures, organizational ecology and external archives. Ackerman (1998: 211) expands this list to internal information repositories, such as manuals, databases, and even filing systems. Individuals are prime locations for retention of organizational memory. Organizations contain two basic types of organizational memory. The first is hard data such as numbers, facts and rules (explicit knowledge), while the second is more along the lines of incidental participatory data such as expertise, experiences, anecdotes, and details about practices and procedures (tacit knowledge). What is needed are ways to store and retrieve the second type of data-participatory.

1.3. PROJECT MANAGEMENT

1.3.1. Emerging Project Management Techniques and New Challenges

Even though project management principles and tools had been established for quite a long time, successful implementation and standardization in project management systems in organizations is still a contemporary issue; especially for the practitioners and R & D researchers (İyigün, 1999: 67-69).

Thamhain (1999: 144-120) highlights traditional project management tools and techniques, such as PERT/CPM, budgets, variance analysis, schedules, schedule tracking, prototyping, stakeholder management, and project reviews are considerably more popular among professionals than contemporary techniques, such as schedule compression analysis, self-directed team, enterprise resource planning, incremental dynamic tracking, requirements analysis, simulation, Internet/websites, virtual teams or virtual organizations.

1.3.2. Goal-Directed Project Management (GDPM) Methodology and K-P-S-O Concept

One of the contemporary techniques, which, in our consideration, must be added to the Thamhain's list, is GDPM. The method presented in the book by Andersen, Grude and Haug (1995: 3-25), contains procedures and tools, which support project management and shows how to organize resources in an organizationally complex situation. The two characteristics of GDPM methodology, which set it different from traditional project management techniques, are description of required changes relating to People, System and Organization (P-S-O) goals and focusing not only on planning, but also on managing.

GDPM is interested in P-S-O projects. P-S-O stands for people, system and

organization. P-S-O projects are projects where development of a "*system*" and development of *"people"* and *"organizations"* will occur simultaneously. This concept by Andersen, Grude and Haug (1995: 90-91), emphasizes the importance of balancing all three elements.

We have added one more component to these three factors, *"knowledge"* which is thought as significant as others are. As Newman (1996) emphasized, knowledge is the full utilization of information and data, coupled with the potential of people's skills, competencies, ideas, commitments and motivations. In our consideration, P-S-O concept must be converted into knowledge-people-system-organization (K-P-S-O) concept. In K-P-S-O projects, goal management is absolutely essential. But the goal is more abstract in these projects. GDPM shows how to organize resources in an organizationally complex situation, how to set goals, and break each goal down into controllable intermediate goals, and how to divide work tasks and then monitor them.

1.3.3. Changes in Formation and Operation of Teams in Organizations and The Nature of Virtual Teams

The nature of teams has been changed significantly changed because of the changes in organizations and the nature of the work they do. Organizations have become more distributed across geography and industries. Relationships between people inside an organization and those previously considered outside (customers, suppliers, managers of collaborating organizations, other stakeholders) are becoming more important. Organizations have discovered the value of collaborative work. There is a new emphasis on knowledge management, harvesting the learning of the experience of members so that it is available to the whole organization. All these changes in organizations have changed how project teams are formed and how they operate (Kimball, 1997:17-28).

The strong decentralization of industrial R & D efforts, lead to more and more cross-locational collaboration. Difficulties inherent in effective teamwork and communication are the lack of corporate knowledge, in one sense organizational memory and effective project communication. Virtual team organizations were hailed as the solution to these problems and virtual project teams have been formed.

In reality, virtual teams are teams of geographically and/or organizationally dispersed employees who come together to complete a project and then disband upon completion of their work. Virtual teams are teams working with digital space across time and physical boundaries and are linked by webs of information and Internet technologies, where there is no central project office, no supervising organization, no hierarchy, and no vertical integration. The Internet and web have evolved into more than just a communications medium

for static publishing. With a broad user base and the maturity of Internet and web technologies, it is emerging as the platform for wide area collaboration (Chan, 1998).

1.4. MULTIMEDIA OBJECT RELATION NETWORK (MORN)

At the initial stages of the *"Technology and Rural Development: Assessing Technology Needs of Southeastern Anatolia Project in Turkey"* project; Öner, Başoğlu and Türe (1999) have became aware of a list of needs related with project management and modeling. Analyses of the problems have led them to some specifications. They proposed an information system for knowledge organizations and called it *"MORN".* The system is based on a *"semantic network",* which is published on the web, where team members have the opportunity to access and manipulate this network (Başoğlu and Öner, 1999a). MORN is a knowledge base applied as an information infrastructure of a research project.

Başoğlu and Öner (1999a) highlight that the system has been designed to store any sort of objects (abstract or concrete) with the objective of establishing a harmonic unification of information. Thus, it is an object-based system where concept indexes; external and internal links can be attached to multimedia objects to visualize the series of steps of research activities, concepts and their relationship. The model consists of nodes and arcs (link). Each node, as an object, represents an idea, statement, concept, document, hypothesis, web site, book, report, interview, article, news, question, story, meeting, etc. The daily operation is collecting and storing any piece of *"thing"* in the knowledge base, then gradually locating the objects at the most appropriate *"positions"* (Başoğlu, et.al., 2000). For node class, the model has some predefined sub-types; such as, article, book, concept, e-mail, interview, journal, meeting, methodology, organization, person, product, project, questionnaire, question, report, software, statement, thesis, and web site. There are various relationship types: oppose, support, be part of, redefine alternative relationship, decompose/multi-layer and conflict.

Some nodes may be members of a super node (figure 2). In such a case, a part-of relationship may be established between nodes. Redefine relationship may be a set when a statement is refined and declared as an alternative of another statement (Başoğlu, et.al., 2000).

External links may be connections to web sites, to documents on the server, to multimedia objects (sound, graphics, picture, video fragments, and animation) or to an executable program. A score, which denotes the strength of relationship, may be assigned to links (Başoğlu and Öner, 1999a).

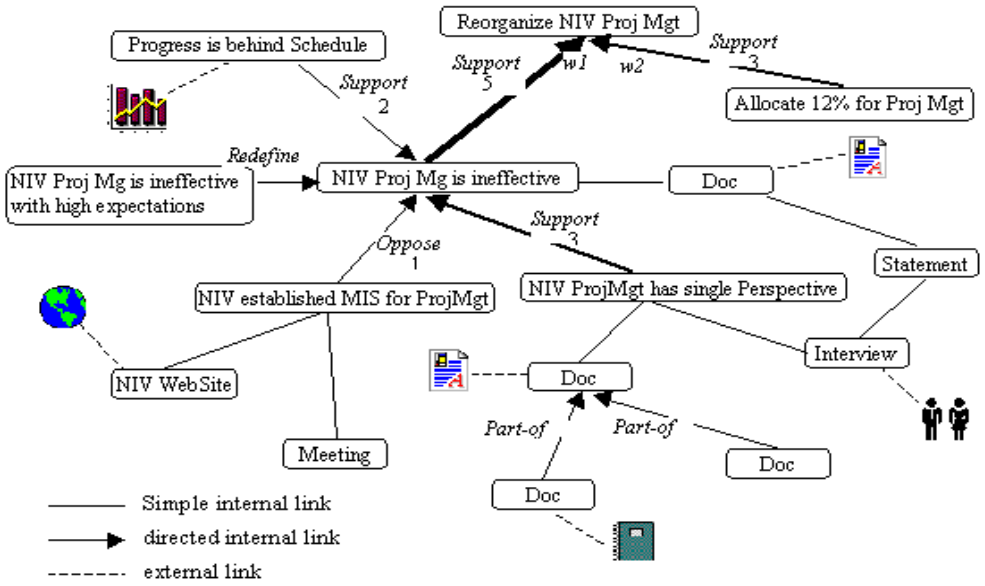

Figure 2: Type and direction of links between nodes (Başoğlu and Öner, 1999b)

2. A FIELD STUDY OF MORN IN R&D PROJECT MANAGEMENT

MORN seems to offer an alluring application, providing the possibility of capturing portions of an organizational memory at a relatively low cost to that organization. But, *"would it work in practice?"* To determine whether it works actually, a field study of MORN in concurrent R&D project management were undertaken.

Most of the research articles in this field are addressing the role, value, dimensions of knowledge from strategy, economics, philosophy views, while fewer discussions locate in how to manage knowledge and how to capture organizational memory in operations (Amidon, 1996; Ackerman and Halverson, 1998; Davenport, 1999).

It has long been known that collaboration is a social process that cannot be studied in isolation from its context. Laboratory tests with prototype organizational memory systems do not generalize to everyday work practices. It is now an accepted view that the usability of such systems can only be assessed in natural situations (Ackerman and Halverson, 1998). The requirement analysis, therefore, should not only address the functional capabilities but more importantly, focus on the practical usability of the system. For this reason, the best way is to attempt evaluating field tests with existing

technology. Thus, the success of the project is determined by the usability of its results: the satisfaction of the users participating in the field tests and, more importantly, the diffusion and continuous use of the system.

Within this organizational memory research there were essentially two strands, which reinforces each other. These two strands were *"technical research"* (the design and construction of the system to support information sharing as an organizational memory tool) and *"social research"* (qualitative studies of organizational memory and use at the micro-sociological level). Below case research, in depth, has been presented concerning these two strands.

2.1. The Settings for the Study and Goals

It has been studied a research project (here called MORN Project) involving different partners in five cities in Turkey and one in Turkish Republic of Northern Cyprus. The involved partners were partly academic and non-academic.

In this study, usability of MORN in concurrent project management in Military Research Group (MRG) and probable contributions to organizational memory has been investigated. The research studies of each member of MRG (totally 8 sub-projects that are interrelated with each other in terms of their subjects) have been examined as separate projects. By the end of September 1999, two new sub-projects were added. Since the major elements of MORN system are people, it was aimed that this study discovered new findings about human behavior that might have been led to a better system design.

This was a field study, because it examined attitudes and behaviors of MRG members in their work environment. Variables were neither controlled nor manipulated, and no artificial setting was created for the study. The natural setting was the direct source of data; MRG meetings, mutual effects of members in daily life especially using MORN, e-messaging between project members.

The study was conducted over 5 months (June to November). All data for this study have been harvested over this period.

The purposes of this study were primarily twofold in nature. The first main goal of this field study was to develop and to improve a web-based distributed multimedia information system for storing, accessing and sharing specialized, updated, and high quality information as a practice of capturing organizational memory. The second one was, as an implementation of virtual teams, to manage geographically distributed R&D projects concurrently using MORN software.

As sub-goals, this study also attempted to test and evaluate the usability of

MORN as well as to analyze the capability of teams to interact remotely in a virtual team environment. One of the objectives was to observe to what extent the disadvantages of geographical distance could be overcome by MORN. Finally this study aimed at utilizing GDPM methodology in concurrent project management, which allows interdisciplinary interaction. As another sub-goal, of particular interest is to reveal the level of improvements on the core competencies of project members in a virtual team environment.

During the research, following statements have been attempted to be clear.

- To what extent MORN can be used in Turkish Land Forces for storing, accessing and sharing specialized, updated, and high quality information as a practice of capturing organizational memory in concurrent R&D project management?
- How can the disadvantages of geographical distance in virtual teams be overcome by information technologies?
- How organizational memory (or in our case, project memory) can be maintained and to what extent the organizational memory barriers can be passed over?

2.2. The Participants, Sampling, Competencies and Roles

The project and team members are hypothetical for the sake of confidentiality. The MORN Project was a distributed activity involving different people with various roles, competencies, and backgrounds in various locations. The distribution was both intellectual and also geographical. The geographical dispersion is portrayed below in figure 3.
The geographic dispersion of members, who are located in Istanbul, is illustrated below in a more specific map (figure 4).

Figure 3: Geographically Dispersion of Participants in "MORN Project"

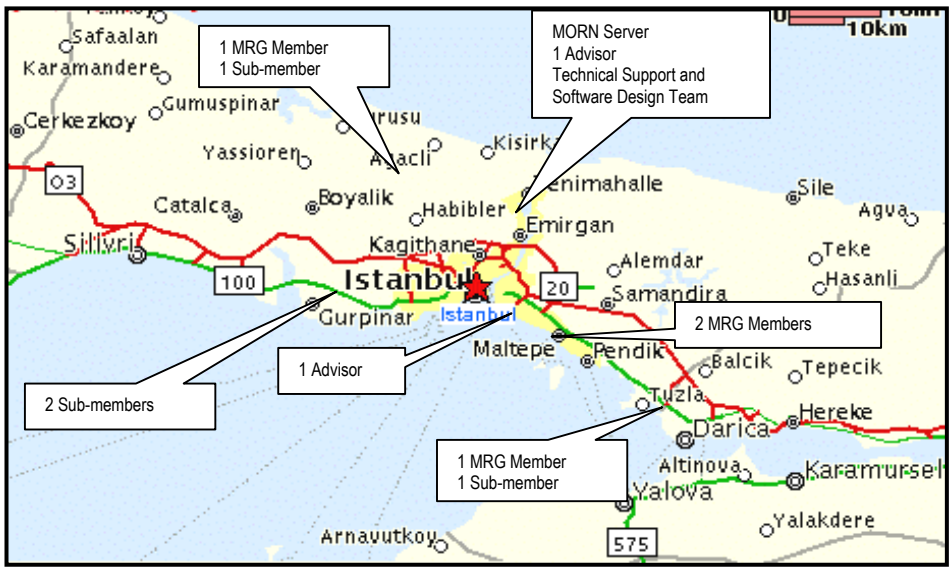

Figure 4: Dispersion of Participants in Istanbul.

Our virtual team, consisting of 24 members and 4 functional groups, were recognized within the project. As advisors, two faculty members coached and supported the whole process. Each MRG member (totally 10), as the project manager, was in charge of his/her R&D sub-projects. Academicians, R&D project managers from defense industry, project officers from Turkish Land Forces, etc. participated as the members of sub-projects (totally 8) in various locations throughout Turkey. They were called as distant project members. Technical Support and Software Design Team were information systems researchers and students (totally 4) from the MIS Department of Bogazici University. Figure 5 below illustrates the structure of MORN Project group.

The advisors played the role of instructor in the studies of MRG members and coached in all activities. While doing research, project manager played the role of ***"participant-as observer"*** (Fraenkel and Wallen, 1996: 416) and were responsible in overall management of MORN Project. The sub-project managers' role was two-folded, consisting of deciding the requirements, testing the MORN and managing their own projects. Also, all the participants played a ***"developer role"*** at a requirement stage of the design process. Technical staff was mainly responsible for implementing the system, but also played an important role in solving the urgent design problems. In sum, the virtual team was the ***"prosumer"*** (producer and consumer) of its knowledge.

The population for the study comprised members of MRG. It could be tried to obtain information from those who were not most conveniently available.

Instead, it was decided that the original MRG members (totally 8) were the only ones who could give the needed information during the project. In other words, these MRG members were perfectly representatives of the population. Thus, ***"judgement-sampling design",*** one of the *"non-probability and purposive sampling"* designs (Sekaran, 1997: 239), has been applied. Having

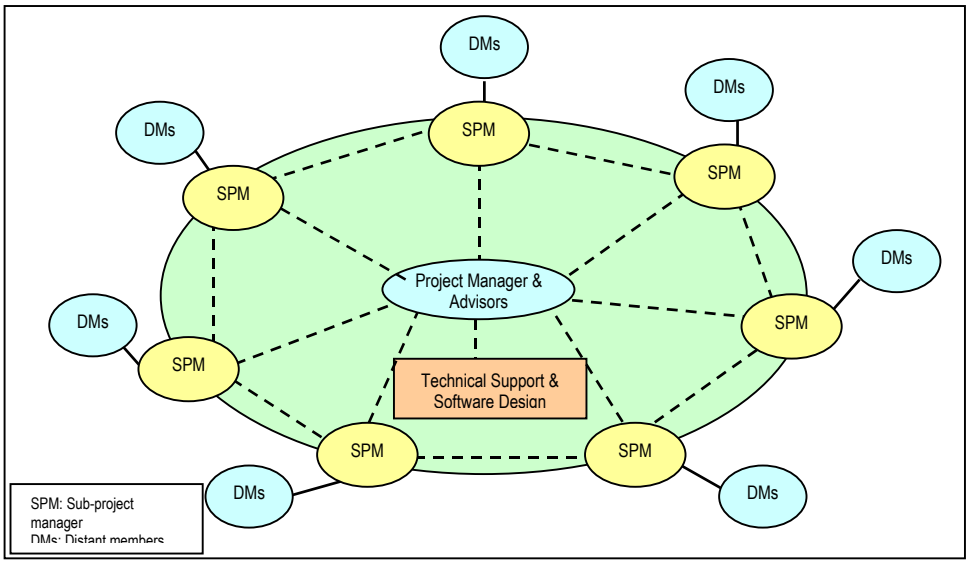

Figure 5: Structure of MORN Project

themselves gone through the experiences and processes, they were expected to have expert knowledge and be able to provide good data for our study.

2.3. Communication Infrastructure

Project administration (advisors, and sub-project managers) had regular face-to-face meetings every 15-20 days. At the outset of the project, the frequency of these meetings was higher in comparison to the posterior phases of the project. Project administration came together rarely in August, since a very serious earthquake occurred in the seismic zones of Turkey. Most of the project members participated in first-aid organizations as *"volunteers".* In addition to these meetings, almost all communication was done on the Internet using e-mail and MORN as the main collaboration medium.

As is the case in many virtual teams, e-mail quickly became the standard communication media as an asynchronous mode by keeping all participants in touch with developments. Person-to-person e-mail within the team was restricted to exceptional circumstances so that group synergy is enhanced. At initial usage, detailed mails that are of interest to only two or three people wasted the time of the others. This was alleviated by careful use of *"subject"*

headings in the mails. Also, a special e-mail-list server was set up in early stages to make all messages available on the web and automatically distributed to all team collaborators. No outsider could post messages or receive team members' messages. By means of this discussion net, different aspects of the project have been discussed deeply.

Throughout the project, the members used web page of the project as an alternative way of sharing project information. When a person was new or began to work on one of the project, the person could easily get some background information about the project phases.

It can be deduced that MORN is not a radically new system. In one sense, it shows how a relatively simple combination of well-known concepts can provide a surprisingly powerful platform as a new kind of cooperative work application. MORN as a tool for capturing and exploiting organizational memory that was previously stored formally or not at all, has played an important role. MORN is an asynchronous medium. It was restricted to the project teams and protected from external use by a centralized authentication service. Access was password-controlled. It is beyond the scope of our research to go into the area of "security", a detailed study can be found in one of the sub-projects conducted by Ertürk (1999).

2.4. Instrumentation, Data Analysis and Assumptions

The collection of data in study was ongoing. The study used multiple data collection procedures including initial, mid and final questionnaires, critical incident interviews, and field observations. All activities in MRG have been fully participated, but also made it clear that a research study were being done. Everything relevant to usability of MORN was recorded practically that was observed, that is, ***"unstructured observation"*** method was used.

To check the accuracy of the impressions gained through observation, structured and unstructured in-depth interviews have been conducted either face to face or by telephone. Because information recalled from memory is imprecise, some interviews were recorded if the interviewee had no objection. Also, a daily log in PC version of MORN was kept in which all relevant to usage of MORN, milestones of concurrent project management, meetings, deadlines, technical or managerial problems, etc. have been recorded. Several kinds of pre-formulated written set of questions were administered personally or e-mailed to respondents. The details will be introduced in depth later in this paper.

After questionnaire and interview responses, the observational and daily log data have been gathered; the data then were organized, coded, and categorized in terms of variables. The observational data was used to supplement the qualitative evaluations and quantitative usage data. In

general, this coordinated effort was made to use the qualitative and quantitative data together.

Data analysis depended heavily on description; even when certain statistics are calculated, they were used in a descriptive rather than an inferential sense.

To check our perceptions and to enhance validity and reliability, some common procedures in qualitative research were used:

- Using a variety of instruments to collect data such as questionnaires, observation, interview etc. (triangulation).
- Checking one informant's descriptions against another informant's descriptions, interviewing individuals more than once.
- Documenting the sources of remarks and bases for inferences, using audiotapes when possible.
- Observing the setting of interest and usage of MORN over a period of time.
- Using or adapting well-known questionnaire designs and asking the same question in different ways.
- Establishing rapport with MORN users as much as possible before administering questionnaires.
- Stating questions carefully so that the interviewee does not prejudice his answers.

Planning the project presented some challenges. First the computer skills of the sub-project managers were expected to have a sufficient level. The second assumption was that all participants had strong desire for cooperation and collaboration in a virtual team environment.

2.5. Requirement Engineering

Figure 6 shows the research stream that began with the MORN system. Within this research stream, technical and social researches have been done, which reinforced each other.

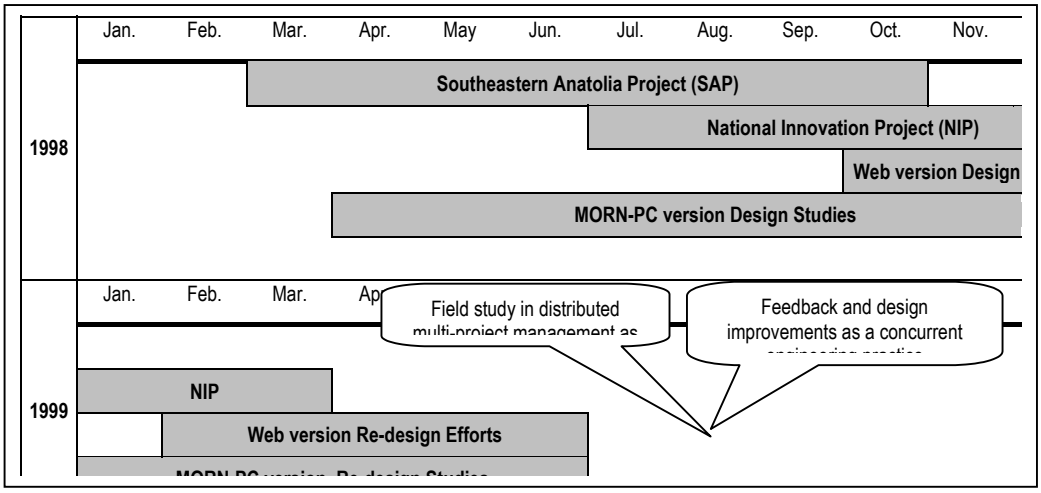

Figure 6: MORN Research Stream

The first phase was the ***"product development"*** step of the product life cycle. Then the product, MORN, has been put into practice as the ***"product implementation"*** phase. In the context of ***"requirement engineering"*** (Wieringa, 1996: 48-54), the third phase can be called as ***"product evolution"*** step. This field study was the third phase in the journey to a perfect tool for organizational memory. It is expected that, in the light of the findings of this study, the technical support and software design team will achieve the ***"regulatory cycle"*** as the last phase of requirement engineering.

During the MORN Project, both the product and process have been implemented and improved concurrently. While completing their projects in concurrent execution, the project members, as the dynamic participants of design procedure, decided the requirements, tested the MORN and provided feedback about their perception.

2.5.1. Customer Feedback Cycle: Prior to full-scale implementation the key group, which was consisted of sub-project managers, tested the procedure and the MORN for debugging. The focus of the tests was on user interface adaptation. In this improvement process of MORN, the bugs, problems, deficiencies, and recommendations were systematically transformed into the precise requirements of software. MORN and mailing lists were the two main forums for providing feedback. All the bugs and recommendations reported during this period were listed in the system as 10 different nodes and they linked with each other.

Another important thing is that feedback was not only provided by the end-user, but also by the technical staff and advisors, especially on the future functionality of the system. Then all of them were categorized and put together as a questionnaire. After using MORN for a month, the key group applied the first *"MORN Design and Usage Evaluation Questionnaire"* on 15th of July. In this questionnaire, the participants were asked to decide the priority of 44 different topics. In the light of the customer feedback, the Software Design Team fixed 26 major problems, which had been labeled as *"urgent items".* A few topics were accepted as technically unfeasible. Another group was postponed until the MRG members judge collaboratively what and when to do. Same procedure was repeated once more between July 15 and November 15. The 2nd questionnaire contained a list of 29 new requirements for the tool. Approximately half of the bugs were resolved.

In this evolution process, the most attractive point was that almost all of the respondents agreed upon the urgency of the bugs related to the ***"recoverability"***. Each of them, as an end-user, accepted that the ability to take corrective action once an error has been recognized was the most important and urgent feature of MORN. To satisfy this requirement, some corrections were made, e.g. ability to change the project code of a node was added to the options.

The second important point was the ***"flexibility"*** referring to the multiplicity of ways the user and the system exchange information. After hard work, the Software Design Team was able to add a new data field, which can store up to 250 characters on the new record entry screen.

From our interviews and observations, it was obvious that a detailed ***"help screen",*** especially for novices, was needed. To simply introduce the new users how they should operate on MORN, a detailed ***"MORN User's Manual"*** was prepared and distributed via e-mail to all users. Meanwhile, Software Design Team accomplished an enumerative and hypertext on-line help screen and a ***"question field"*** to the help screen, and then by clicking the *"send"* button, all users were able to send a message about a problem directly to team's e-mail address.

2.5.2. Resolving Design Issues and General Problems: After software is developed and put into service, according to feedback from pilot or end-users, some changes must be done in the properties of the software. As explained before, this phase can be called as ***"product evolution phase".*** Product evolution phase during MORN Project was charted in figure 7. When an issue was arisen the normal practice was to send e-mail about the issue to the mailing list. All the members could read and publicly comment on the issue as in a brainstorm application. This was very useful because members' viewpoints have been collected rapidly. In all cases, we were responsible for

collecting all the feedback and make a summary of viewpoints as a node in the system. Thus, tacit knowledge of the virtual team was transformed to the system to maintain organizational memory.

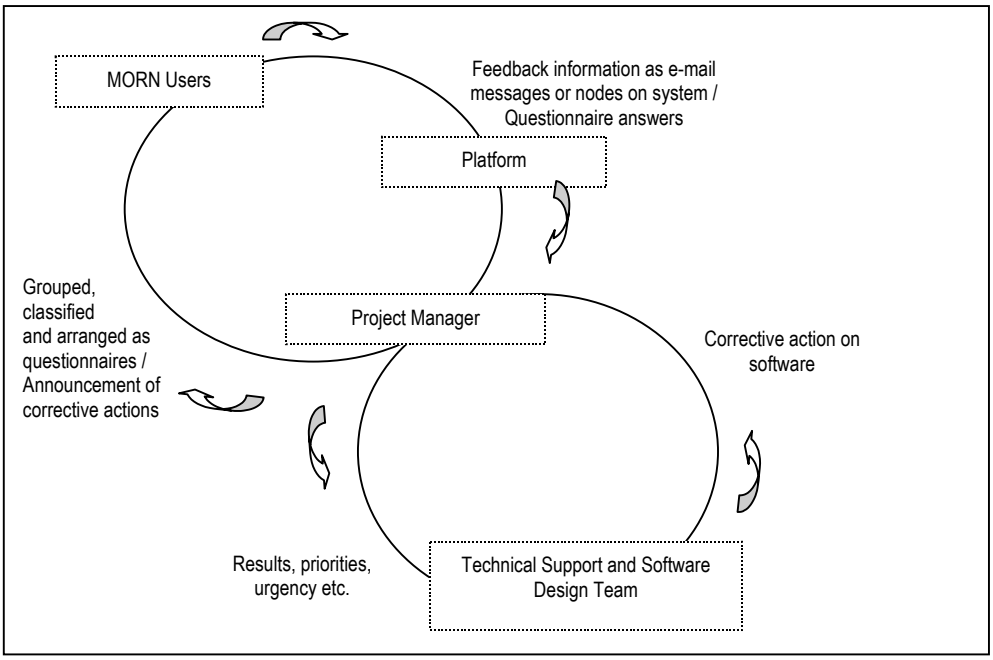

Figure 7: Product Evolution and Resolving Design Issues

The first issue was the response time of software. MORN was accessible from all computer platforms from any of the sub-projects' locations, using Internet as a communication backbone. But as a web- based system over the Internet, it has the same problem: response time increases depending upon the traffic. The biggest issue was that every click on screen needed message traffic on the network. In the light of users' feedback, the technical staff made some changes in MORN screens such as removing a few images, which take relatively longer time to load.

Among the other problems encountered, electricity cuts on MORN server presented a severe obstacle to the project. Once the electricity was off, MORN server, unfortunately, remained down. Because at the initial stages of the project, there was no uninterrupted power supply unit plugged into the server.

2.6. Patterns of Use

2.6.1. Foundation of the Virtual Team and Project Culture: One of our

goals was to realize an efficient knowledge management and naturally, capturing organizational memory. However, at the beginning of the project, most of the members have not recognized the term *"knowledge management"*. There was no concern about knowledge sharing, since they needed to share knowledge to get the work done. All they knew was that the electronic workspace would help them progress their work and remain connected to their colleagues, without continually having to travel. Afterwards the virtual team was aware that they were the producer and consumer of their knowledge. By means of this common conscious, a project culture was formed online, which reinforced and expedited the willingness of knowledge sharing. The emphasis was on the cooperation requirements of technical and management professionals working in different organizations and using heterogeneous technical environments. Then, MORN and Internet have become the main collaboration mediums.

2.6.2. Group Creativity and Virtual Team's Synergy: As an interactive form of sharing, regular project administration face-to-face meetings were very advantageous. These meetings can be labeled as the extraordinary sources for group creativity. All of the participants were all of the same opinion that group creativity was not the simple aggregate of individual team member's creativity. Our team creativity was more a function of member creative performance, interacting project members, projects group characteristics, group processes, and perceptions of work environment. This creativity was materialized through these meetings. As a collaboration platform, MORN facilitated and supported the group creativity, too.

At the second week of the study, in a face-to-face session, all sub-project managers were introduced with MORN and distributed user names and passwords. No additional session was organized and all members began to use the software. Even, remote members had to learn the software by their own practices. But, our experience revealed that all users must have been well educated regardless of project focus. Instead, it was waited from users to discover the properties of software. As a matter of fact, this was, certainly, a mistake on our side.

As MORN network became larger, it was not so easy to associate new entry nodes to existing ones: a pre-defined list of keywords, in their own hierarchical relation, should have been added to the software. A face-to-face meeting was concluded with totally 52 co-decided keywords. The interaction was a good example for group synergy. Later, this interaction was continued on-line, either by e-mail messages or by questionnaires.

To enhance the interaction between related sub-projects, an acronym (project code) for each sub-project was described with the contribution of all users, and then all were clustered. Since every user had a project code, this code

was automatically assigned to related node. Thus, users were automatically able to see the nodes, which were defined in their clusters. When a user thought that a node was very useful and should be shared by all users, then s/he assigned the project code of this node as *"com"* meaning *"common nodes".* It was agreed that keeping nodes of different projects in different clusters and assigning some nodes as common provided an effective utilization throughout our virtual team.

2.6.3. Empirical Analysis and MORN on Usage

Due to the intense use of electronic communication, the project itself provided quantitative data on how it has evolved across its life cycle. Below analyses focused on MORN and e-mail usage are described.

MORN was designed to be a system that would be used asynchronously. In this respect, the collaboration on MORN was obtained erratically. MORN's use was not uniform across the test period. At the end of the period, 12 users (including advisors and sub-project managers) were logged in MORN totally 537 times. The maximum that a single user logged in the system was 167 times over the project period. Maximum average number of log-in count per user = 44,75 in the last stage of the project. It is likely that this was one of the indicators of the existence of our project memory. Despite, the rate of assigning new nodes slowed down in October, the number of log-in count continued to rise. It can be inferred from this result that users have, though partially, started making use of project memory.

Because of the deficiency of sufficient usage instructions, MORN's utilization was quite limited initially. Furthermore, in the second half of the August, utilization slowed down and assigning any node dropped because of the earthquake mentioned above. Afterwards the utilization was higher as users experimented with the application.

Sub-project managers and distant members showed different usage patterns. Actually, the latter preferred to be in contact with their own project manager rather than project administration. To share knowledge, they used e-mail messaging more than MORN platform. For this reason most of the analysis introduced in this section was based on the data, which was obtained from other users.

A simple table of the nodes defined in the system by users shows that 3 users were *"heavy"* users, accounting for approximately 74 % of the total nodes. In our consideration, the qualitative responses indicated that the standard problems in introducing a new software system were present in our study. For example, some nonusers (especially distant project members) had some difficulty in connecting, while others did not want to spend their limited time to learn the software.

The definite trend was recording explicit knowledge rather than tacit knowledge. Approximately, 10 % of the nodes were belonged to informal sources such as statement, interview, meeting, and question. Users preferred to share their formal knowledge sources such as article, book, web site, report, and journal.

Based on the analysis below it was concluded that all users assigned a score to nodes depending on their perceived importance. Thus, the crowd of insignificant nodes within the list was pushed down. In one respect, a few of the users were very sensitive in assigning scores; they used the scores of 99, 98, 88, 72, etc. Actually, MORN was designed to automatically assign *"50"* by default in case of a user forgot to fill the score field.

MORN's design lets users to make external links including web sites, multimedia objects and documents on the server. After placing a node and defining the file extensions in the system, the user e-mailed the documents or multimedia objects as an attachment to the system administrator. Thus, all was visible and downloadable by other allowed users.

To lower the effects of response time, majority of users have chosen to send their documents in *"html"* format, which took relatively shorter time to load. Since English was used as formal language in all of the sub-projects, 77 % of all nodes, naturally, pointed out an English source.

Users preferred to establish links in general type *"related".* They linked nodes with the *"supports"* relationship type rather than *"oppose".* This was very normal since during project period, members strove to collect supporting objects to get their works done. *"Redefine"* relationship was selected with a percentage of 1. It could be set when a statement was refined and declared as alternative of another statement, but users were in trouble in understanding the meaning of this kind of relationship.

Despite 80% of relationships were established between users' own nodes, analysis of number of the links highlighted several points regarding interaction of project members. Actually from the geographical viewpoint, the distances between users seemed not playing any significant role in linking node activities. Another point was that nodes of one of the users were the most preferred ones, since 44% of all relationships were connected to his nodes. To a certain extent, this was the result of his unifying role throughout the project.

2.6.3.1. E-messaging: Frequency of contacts within MRG was a function of advancement of MORN project. With the project deadline approaching, the members of the project team were more likely to intensify their exchanges than in the early stages of the project. Within 5 months, the total of e-mail messages between MRG members was 2011. The advisors maintained their governing role with a percentage of 34.

The percentage of MORN-related messages dropped at the second half of the project as MORN reached a relatively mature level. Management and technical discussions continued throughout the project. The reason for this discrepancy was considered as at the outset of the project, MORN was a new tool for all of the team partners and needed to be improved.

The closer the deadline was, the higher the number of messages was transmitted. Interviews with collaborators revealed that there was no systematic pattern since electronic messaging was driven by a combination of sub-project deadlines and their daily routine. This was unsurprisingly consistent with our expectation. It was observed that e-mail messaging was primarily driven by the need to exchange urgent information.

It was hoped the usage of e-messaging would have dropped in August since a very severe earthquake occurred in Turkey. But, surprisingly, number of management and technical messages burst in August. This explosion was perceived to be in the need of hearing from others. In one respect, the deadlines for sub-projects were approaching, too.

Some of the collaborative partners became steadily more active, showing sudden bursts. The differences between the numbers of partners' messages were considered as the indicator of their roles in the project. For instance, one of the members was responsible to collect and answer overall management issues. Hence, at each stage of the project, his messages were more than any other partner's was telecommunications and computing infrastructure, which varied significantly between partners and cities in which members located, did play an elementary role in the number of e-mail messages. E-mail profile showed that messaging was neither steady nor continuous, but more or less dependent to infrastructure. Since some specific problems e.g. changing ISPs or re-configuring computers were faced and, then, hopefully, solved.

Additionally, the distances between distant collaborators seemed not to play any significant role in e-messaging. The geographically distance between the location of one of the members and Istanbul where MORN server, advisors and project manager located, was about 250 km. The number of his messages was relatively higher than most of the others since he has relatively less chance to participate face-to-face meetings. He preferred to attend e-meetings, one of the outstanding features of web-based project management.

2.6.3.2. Perceived MORN: To get a better understanding of MORN's attributes, a questionnaire in the form of "semantic differential", which was a unique sort of attitude scale (Fraenkel and Wallen, 1996: 416), was prepared. This questionnaire allowed measuring and assessing MRG members' attitudes and feelings toward MORN.

Since two advisors and distant sub-project members are excluded, only 7

partners (sub-project managers) were contributed to semantic differential questionnaire in which MRG members were presented with a continuum of 40 pairs of adjectives such as *"simple-complex", secure-insecure"* etc. Likert style on 5-point scale was applied to the questionnaire. Moreover, they were allowed to state their comments in the field provided below the questionnaire. The questionnaire was applied 3 times; pre, mid and post tests on June 20, July 20 and October 5, and they were labeled as, respectively, *"test-1, "test-2"* and *"test-3".* In fact, it was planned to carry out the questionnaire on August 20; but the earthquake has changed our mind.

All tests were administrated individually, i.e. meaning the respondents were not allowed to discuss the case with one another and were told that their responses would be graded as independent from others. We were present as they were filling the questionnaire except the 2nd test, since it was administrated electronically via e-mail.

Besides, respondents were interviewed to assess their preferences on the questionnaire sheet. These interviews revealed that three pairs of adjectives were misunderstood by a majority of respondents. These were 10th, 13th, and 39th items, respectively *"reliable-undependable", "abstract-concrete"* and *"accurate-inaccurate".* In analyses, these 3 items were not taken into consideration. Based on this frequency distribution of checkmarks on questionnaires, measures of central tendency were calculated to summarize the data with a single number. The four most commonly known tendency measures of averages; geometric mean, arithmetic mean, mode and median as well as maximum and minimum scores were computed.

The critical-incident interviews, conducted with the participants, included some mixed responses: both positive and negative statements. Overall, the majority of comments were favorable. Generally, users have found MORN *"satisfactory"* and *"useful"*, but there were some properties that the system needed to provide additional support.

The highest scores according to arithmetic mean in the test-3 were *"required powerful hardware", "easy to navigate", "colorful",* and *"fast access".* In general, the overwhelming emphasis in the usage evaluations was that users were satisfied as long as they accessed MORN quickly. More importantly, response time while surfing through MORN was quite long. Nearly all users (95%) complained about the time required for searching or entering a new node. The values of standard deviation of *"fast access"* and *"easy to navigate"* criteria were same: 0,88. In one respect, this value represented the common perception of all users that MORN was a relatively slow platform.

Another criterion perceived as the most unfavorable was that MORN *"not required powerful hardware".* A careful examination revealed that the scores of this criterion varied between 1 and 5 with a mean of 3,57 and a standard

deviation of 1,50. This was the indicator of great difference of users' perception.

One more issue was the coverage level of MORN, especially the facility of entry any sort of knowledge, long texts, or any kind of multimedia objects. In the 1st test, almost all of the users thought that MORN was *"limited"* with a mean of 4,71 and a standard deviation of 0,45. By the middle of the field study, their opinions began to change, as they were more familiar with the system. Despite this variation, this criterion remained as one of the unfavorable attributes of MORN with a geometric mean of 2,25 and a median of 3 in the 3rd test.

Four features of MORN were considered as the best attributes with a mean of 1,29 in the 3rd test. These were *"useful", "systematic", "efficient"* and *"essential (in project management)"*. An interesting finding was that the values of standard deviation were 0.45, the lowest value among all criteria. Nearly 90% of participants pointed to MORN as providing knowledge in a systematic manner they would not have received elsewhere.

A second group was formed with five different attributes; *"guide", "cooperative", "cheap", "supporting GDPM"* and *"supporting concurrent engineering".* The values of mean and median were 1,43 and 1 respectively. This result was accepted as normal since the basic reason of designing a MORN was to share knowledge and capture organizational memory. They found MORN as supporting concurrent engineering because they lived this process as active partners.

The only cost of our virtual team was the cost of connecting to Internet in order to search on MORN, to surf in the project web pages or to send/read e-mail messages. Our team thought it was a usual activity. The ratings in 3 tests were confirmed this perception for the cost criterion (*cheap-expensive*).

The items 29, 31, 32, 33 and 34 were assessing the *"applicability"* of MORN in different areas: battlefield, acquisition, research, inventory and personnel management. The comparison the average ratings on each item revealed that almost all users found MORN as *"applicable to research"* with current facilities. The ratings varied between 1 and 2. The final test resulted with a mean of 1,29 and standard deviation of 0,45. In a face-to face meeting, the partners were told to think out loud about applicability. Their opinions were coherent with their ratings in final test. They did not expressed that MORN cannot be used in such different areas, but all agreed that some changes must be done in the design of the software.

The values of median and mode of *"applicable to research"* were both 3 and standard deviation was 0,99. This means, all respondents, except one user, were of the same opinion that it was very hard to use MORN or any similar

system in the battlefield.

2.7. Performance Evaluation

Without venturing too far into the field of speculation, it can be conjectured that people make teams, not technology. And neither any technology nor neither any tool can guarantee project team effectiveness, only skilled and prepared team members do. As outlined above, information technology facilitates managerial problem solving but it can not create a miracle by itself. For this reason, it was believed that team members were the most significant elements in MORN project. During project period, the performance of MRG partners was evaluated in the context of team dynamics with two distinct methods. First method was primarily dependent on our observation and some statistical data. Second one was an application of *"Team Member Contribution Evaluation Form"*, which was used by *"Turkconsult Innovation and Technology Relay Center".*

2.7.1. MRG Performance Evaluation: As underlined above, all collaborators, especially focusing on their behaviors, reactions, contributions, communications, etc. have been observed. Then all findings and observations have been kept in a daily log. Then an evaluation form has been prepared and labeled as *"MRG Performance Evaluation Form"* (MPE). In this form, all partners were rated in terms of their collaboration level, active use of e-messaging, using of Internet and MORN facilities to reach team goals, meeting team deadlines, and following up on team decisions. Absolutely, all was *"subjective"* evaluations depending on observations. But some criteria were based heavily on numerical data such as, attending team meetings, number of e-mail messages, log-in counts to MORN, number of nodes in MORN. This evaluation was conducted at 3 different stages of the project: August 1, September 1 and November 1. The scores and members' sequence was e-mailed to partners. Correspondingly, advisors have drawn a goal for each member to overpass the score 90 at the last stage of the project. Indeed, this evaluation stimulated MRG members to work more collaboratively.

In sum, both evaluations concluded some significant changes in partners' behaviors. For example, they kept, in general, team members informed of progress on assigned work, provided advance notification of face-to-face team meetings delays, and maintained positive outlook/sense of humor in stressful situations.

An interesting finding was that the ones, who found MORN as *"supporting GDPM"* and *"essential in project management",* were the ones who were in the top of the list of performance evaluation tests. Actually, two users went to the fore. This finding was exactly consistent with our expectation; *"A good project manager (or member) also performs well in MORN platform".* Thus, it can be inferred that a person, who is good at project management, will execute the

project processes better, if equipped with a web-based knowledge management system like MORN.

Two members were the last two participants in three MPEs. When the log-in counts were examined, number of node/link entries, or e-mail messages, they preserved their places in the sequence. This denoted that these members were unwilling in a virtual project management process. This result was independent of their geographic locations since the ones who participated from more distant places, were in front of them in all kind of evaluations. It can further claimed that the collaborators were very important in managing virtual projects as well as in using *"knowledge sharing platforms".*

2.7.2. MRG Multi-factor Team Member Contribution Evaluation: As deadline of the project approached, it was decided rating each member of the virtual team on several teamwork dimensions. So, in the last quarter of the project period, a more *"objective"* evaluation questionnaire was applied; all partners were rated on a 5-point Likert scale by each other. The questionnaire, which was used in numerous project teams in Turkey, included 23 items under 3 different headings; *"interpersonal dynamics", "contributions"* and *"team meeting dynamics".* MRG members were. All respondents were told the results are confidential.

One of the members was pointed out as the best in most of the items. According to all members, she/he took initiative to resolve deadlocks, provided assistance to other team members when needed and completed fair share of virtual team workload rather than other partners. To conclude, it was the result of his/her role in the project.

The above-described subjective evaluations were conforming to the result of this evaluation. This was perhaps unsurprising, since all of subjective factors were more or less same with the items in this evaluation form such as providing assistance, actively participating in discussions on project-related issues, attending team meetings (face-to-face or on-line) to discuss assigned topics.

2.8. Organizational Memory Barriers

Information technology has enabled organizations to generate and retain mountains of information. Nevertheless, though many organizations have the information they need, they don't know they have it. Or, knowing they have it, they can't find it. Many studies in the literature would like to find ways that information technology and especially organizational memory systems can support business processes (Abecker, et.al, 1998: 45; Liao, et.al, 1999; Murray, 1999a; Borghoff and Pareschi, 1999: 15-16). However, to accomplish this, one need to understand which obstacles stand in front of the organizational memory. The research on this domain remained limited in the

world. In the second half of 1990s, only, a few researchers have provided the results of their studies (Ackerman, 1994: 37-42 and 1998: 215; Conklin, 1996a).

2.8.1. Formal and Informal Knowledge

Formal knowledge is the stuff of books, manuals, documents, and training courses in the form of reports, white papers, plans, spreadsheets, designs, memos, etc. Informal knowledge including ideas, facts, meanings, questions, stories, etc is the knowledge that is created and used in the process of creating the formal results. If formal knowledge is the foreground, this knowledge is the background. The latter is wild, hard to capture and to keep (Sveiby, 1997).

MORN has been designed to store any sort of objects: abstract or concrete. Thus a harmonic unification of knowledge is established. Each node, as an object, represents an object regarding both formal and informal knowledge. In our project, users stored many kinds of formal knowledge multimedia objects as a node such as reports, articles, news, pictures, charts, etc. Also informal knowledge, in one sense *"wild knowledge"* (Sveiby, 1997) was stored as pre-defined node type such as statements, interviews, etc. Thus, users were able to record their opinions, questions, suggestions, interviews, decisions, guesses, ideas, assumptions, stories and points of views.

Meetings were the intensive sessions to share our knowledge, in particular tacit knowledge. To record what was discussed or concluded in a meeting, every member mailed a *"meeting analysis report".* Hence, it was tried to make tacit knowledge explicit. Furthermore, some of the significant reports were transferred to MORN as nodes. Thus, both in in-box folders and in MORN, a shared memory for the project group created coherence within the mass of formal and informal knowledge. MORN, also, served as an organizer. After storing the tacit knowledge and explicit knowledge, users established some pre-defined links between nodes. Thus, an issue or a decision was surrounded by some related objects, which are either formal or informal knowledge.

- **Turkish Culture:** Turkish culture is one of the reasons for the widespread failure to capture tacit knowledge throughout the organization. In other words, Turkish culture is an *"artifact-oriented"* culture; that is Turkish people appreciate results rather than relationships. This is, naturally, reflected in the way Turks do their jobs. Within this value system, tacit knowledge is devalued and ignored. But during the study, members attempted to balance the process and the output. In spite of this effort, the result was not so cheering, since only 10% of the all entries were related to tacit knowledge.

- **Daily or Weekly Digest:** At the beginning of MORN Project, advisors -

keen on the importance of capturing tacit knowledge- instructed the members to write down important ideas, decisions, notes, and communications in email as a daily or weekly digest. Everything went along fine until deadline or milestones approached and the pressure increased. Then virtual team quietly dropped these extra documentation duties in favor of doing their *"real"* works. It seemed as the result of insensitivity of members. Because of this, the ideas created and the decisions made during this highly productive crunch phases of the project were not captured.

- **Notes on Paper, Videotaping or Audiotaping, Historian and Lessons Learned Reports:** To capture the project memory, it did not seem a good solution, to preserve all the documents, presentations, memos, meeting notes, virtually anything that had been written down. If we had indeed preserved, an office would completely filled with stacks of paper, extending almost to the ceiling. A few members have attempted to capture their thinking and learning by audiotaping their meetings and interviews. The key bits of knowledge they needed later on were in there somewhere; but they had no time to listen to it all to find them. Also the project administration did not have the luxury of a project historian whose job is to capture and organize knowledge. Because experiences show that the efforts become part of the standard procedure, it was not strived to create report documenting *"lessons learned"* on project.

- **E-messaging and Groupware Tools:** One might argue that e-mail already provides a kind of organizational memory for organizations which use it, and that it does so at no additional documentation cost to the members. While e-mail does indeed have an acceptably low capture cost, it does not provide an effective record. Because e-mail messages are strictly personal and are stored that way, and because the e-mail record, even for an individual, is so poorly organized and structured that it cannot effectively augment even an individual's memory. So, with email the cost of capture is low, but so is the value of that record for organizational memory. Another point was receiving of e-mail messages to in-box in random order and with no context. In order to establish context, participants had to quote material from earlier messages.

There is no way for filtering e-mail messages. To find any message in the in-box, one can change the order of messages according to dates; there are no more alternatives. Because of lack of filtering and sorting mechanisms, in-box folders are transformed to a pile of messages. That is, many poorly organized messages are stored for organizational memory.

One of the disadvantages in terms of organizational memory blocks is the lack of the ability of establishing links between e-mail messages. The only way for identifying any kind of relation between messages is to store them at the same

folder, which is absolutely insufficient for one individual or throughout organizations. In our case, many different relation types and also the strength of any link differed from relation to relation. These links easily become the glue that held the formal and informal documents together and preserved their meaning.

Finally, it is a way to arrange coming e-mails in different folders named in terms of their scores such as 0-10, 20-30...90-100. Or one can preface the subject header with a code such as A1, A2... But it will not be a solution to organize lots of knowledge. In a project management environment, to apply this method seems to be a very mingled way. Because the entire key symbols and the meaning of scores, must be known exactly by all users and recipients. As the folders become larger, the users may face the lost effect that prevents them from seeing and understanding the complete picture. Besides, simple navigation and search efforts, users had a chance to eliminate the negative effect of such situations. A score were assigned to nodes depending on their perceived importance to push down the crowd of insignificant nodes within the list.

These technical issues and the above social issues led us to reconsider the some properties of the architectural design. It was inferred that; *"MORN should invoke the mail system directly"*. Simple e-mail should be organized within software so that it is filed automatically by the topic contained within the subject line. When a new node is entered to the system, an e-mail message should be sent to the related project members. Then if one needs details, s/he should log in MORN. Without doubt, this was one of the most important features that most users suffered.

Despite these facts, all e-mail messages have been archived throughout the project; but the purpose was analyzing the project process rather than preserving some records for maintaining organizational memory. Other purpose was to leave a material that may be used for future research on the dynamics of virtual team interaction.

Another alternative solution was the group decision support systems (GDSS) or groupware tools. They tend to make informal knowledge explicit, but they generally fail to create a coherent organizational memory because of lack of an effective index or structure to the mass of information collected in the system (Conklin, 1997a). In our case, any sort of groupware tools such as videoconferencing or GDSS was not used. Actually, MORN allows advanced audio storing and compacting as well as video-capturing. For instance, any kind of video fragment, which had been taped during a MRG meeting, might have been stored as a node on the system.

- Implications: These experiments and facts illustrated a useful memory store cannot be created just by capturing lots of information; it must be

somehow organized in ways that create and preserve coherence and *"searchability".* Interviews and observations have revealed that the *"search capability"* of MORN was the most attractive feature of the tool. As one MRG member put it; "...I did not get lost in the MORN's information forest. Because all the thing that I looked at was far from me at a distance of a mouse-click..."

The conclusion is that the creation and use of organizational memory cannot be a by-product. If we are to find ways of preserving the asset of tacit knowledge, we must look within the practices of everyday teamwork and change them. Creating an effective organizational memory system entails creating new tools and new practices, making changes in technology as well as culture. While the technology must be very good and the user interface transparent, the organization must also shift to making capture and use of organizational memory an important and natural practice. This shift towards a *"process-oriented paradigm and culture"* requires organizational commitment and change of culture. And it is the most challenging part of establishing a capacity for memory and learning in an organization.

Since technology innovation and culture change efforts must be designed to synergies with each other, the study focused on the technology issues as well as the issues of R&D project culture.

2.8.2. Documents without Context

Another barrier to effective organizational memory is that the usual approach to organizational memory, preserving documents, fails to preserve the "*context"* which gives the documents meaning, the very thing that allows them to be useful in the future, when the context has changed. Because current notions of organizational memory are artifact-oriented, they focus on preserving, organizing, indexing, and retrieving only the formal knowledge, as it is stored in documents and databases. But especially solutions for wicked problems require a heavy dose of social interactions. Hence work on these problems requires tools and processes, which preserve the context of the work as it evolves.

MORN was designed to be a system that would be used intermittently, not to be a system recording all the informal knowledge as the process evolves as in groupware or virtual meetings. So MORN required some additional documentation effort to preserve the context of the documents. In other words, the context of social interactions must have been keyed into the system. And only after this effort the preserved context have taken the form of a web of information, which included facts, assumptions, constraints, decisions and their rationale, the meanings of key terms, and, of course, the formal documents themselves. In other words, MORN was not designed to capture and automatically add to organizational memory whatever learning and the interactions of the users.

MORN does not have a capability to notify users automatically about new entries by e-mail. Because of this deficiency, users were in trouble to understand some relations, meanings and contexts. It can be stated that, in our case, this technical mechanism will offer great potential for organizational memory.

2.8.3. Relevance and Size

The third challenge for an effective organizational memory system is that knowledge tends to lose its relevance, and thus its value, over time. This is, in one sense, already the case on the web. On the other hand, there is also a risk that too much memory can bring about confusion in the organization. Briefly, the size of organizational memory can be a considerable obstacle.

Indeed, it seems very hard to be drowned in the knowledge pool because of filtering, sorting and clustering mechanisms of MORN. By filtering the nodes according to several properties such as node type, date, project code, source, keywords etc., users minimized the size of the information store. Also many of the users stated that they have customized the filtering capability in term of different parameters such as less or greater than, equal to, or between some parameters.

Another mechanism that users declared as very useful was sorting and clustering the nodes according to their type, code, date, compiler, score etc. Thus, it was easy to find a knowledge chunk rather than to search without sorting nodes.

The second problem of losing relevance over time was overcome by establishing links between the nodes. As a daily operation, after storing any piece of thing in the knowledge base, some of the users located the objects at the most appropriate positions and redefined the relation type or strength over time. To conclude, as relevance evolved over time, the links and nodes in the system evolved correspondingly.

To tell the truth, simple node linking efforts could not minimize the problem of losing relevance over time. The underlying fact was that most of the users entered their knowledge with a considerable delay. How this problem can be solved? This question was much easier than sounds. First, by monitoring the users. Second, more importantly, by organizing *"MORN sessions"*, as a chance to key new nodes and to preserve relevance over time.

2.8.4. Organizational Amnesia

There is a fourth barrier to organizational memory: spurred by their legal departments, a policy of *"organizational amnesia"*: the systematic destruction of all unneeded personal notes and documents at regular intervals. The

thinking behind this policy is that, in the event of litigation or criminal prosecution, it is dangerous for anything to exist in writing that could be used against the organization. Such thinking, where it exists, creates a major obstacle for the creation of organizational memory. It puts everything that is written down or stored in a computer under the lens of *"can this information possibly be used against us."* In one sense, time will tell whether this kind of anti-memory policy is cost effective in the long run, and whether organizations that pursue it can compete as knowledge organizations.

Throughout the MORN Project, members did not concern the policy of organizational amnesia. None of the project participants did feel anxiety that s/he was in danger so that the materials stored can be exploited against our virtual team.

2.8.5. Cost

The use of an organizational memory system adds cost. Not only is there a cost of purchasing, installing, and maintaining the system there may be additional costs of training employees (project members). As profiled above, both perpetuating information technology infrastructures and training people on the creation, sharing and use of knowledge require a budget. And, of course, these costs vary from organization to organization. But cost of ignoring such a system is much higher than making an investment.

In our experience, such a problem was not faced since our tool was already under construction as a concurrent application. The only cost of our virtual team was the cost of connecting to Internet in order to search on MORN, to surf in the project web pages or to send/read e-mail messages.

2.9. Implementation of GDPM and Project Progress Tracking

MORN project was a *"K-P-S-O"* project. The acronym stands for *"Knowledge-People-System-Organization"*. Our experience revealed that successful implementation of virtual team collaboration requires more than a concern with the technical development of software. It must always be accompanied by planned development, both of the affected personnel and of the relationships of responsibility and authority in a virtual team.

The *"S"* had a broad interpretation in our experience. Since an organizational memory software development and improvement efforts have been done, the tool was considered as *"S"*. The most common failing in project work is to focus too strongly on the technical content. In contrast, all the project members did strive to balance all four factors. As Andersen, et.al. (1995: 77-81) argue, in nearly all of the projects, training and motivation of the people are forgotten. In our experience, because *"P"* was considered as an important asset, all members were trained about both MORN and e-messaging. Besides this initial education and orientation, advisors and technical staff were always

available to assist the users when they needed. Additionally all members were given the opportunity to influence the whole process. The *"S"* and *"O"* (MORN and virtual team) were formed according to their priorities, requirements, and comments as a concurrent engineering practice. The third element was *"O"*. The project team was very mindful in the development of people and organization to enable the organizational memory tool to function well. It would have been a very unlucky experience to totally neglect or paid insufficient attention to the virtual team. Project team especially concerned with improving relationships, means of communication and virtual team interaction. In one respect, we all formed a complementary.

As a matter of fact, capturing *"K"* was, in a sense, one of our goals. MORN was our organizational memory storage for both tacit knowledge and explicit knowledge and acted as *"broker"* between input and output knowledge. Therefore, we produced and consumed our knowledge since we all needed to share it to get our work done. It can be inferred that without an effective organizational memory and knowledge management, organizations and project team are simply not equipped with a vision to foresee, to imagine the future.

In sum, MORN Project was a project where the result was a "*composite product"* and there was a balance between all elements. The result consisted of MORN technology, but also of people with new knowledge and attitudes, of a virtual team environment within which the partners could function well, and of knowledge stored in a web-based organizational memory tool. To deal with the management of K-P-S-O project, GDPM methodology that contains procedures to support project management was applied. Not only in MORN Project, but also in most of the sub-projects, GDPM methodology was used.

To visualize the project progress, another table prepared by advisors, was used. All MRG members filled this table weekly and e-mailed to advisors. In this table, hours-plan, hours-acted, progress-plan, and progress-acted have been illustrated. This method was seemed to be very useful since every user become easily aware of whether s/he was behind the schedule or not. It can be proposed that *"project progress tracking table"* be imported to GDPM methodology as a supplementary document.

2.10. Evaluation of Field Study

Every experience teaches something and MORN Project was not an exception. What we learned was *the could have beens* and *should have beens* of an organizational memory tool. The field study resulted in a set of some implications and requirements for the organizational memory system, which is currently under development. Above-mentioned technical and social issues led us to reconsider the architectural design. These findings required some adjustment of the design properties.

As a final comment, it can be claimed that most of the users were of the same opinion about the following evaluations about the software:

- MORN presents a potential method of building an organizational memory. In its emphasis on helping users find relevant tacit knowledge and explicit knowledge to their daily project work routine.

- MORN is not a panacea; it is just a tool. The best place to start is a project or a group like MRG that is having problems. For example, groups whose members work in different places often have problems scheduling some meetings, storing or sharing their knowledge. MORN can become a way to make the ones more productive by supporting them with tacit knowledge and explicit knowledge.

- Morn helps virtual teams: not only to capture and to share, but also to organize, to distribute, and to apply their knowledge to their work.

3. CONCLUSION

The main results of this study can be synthesized into following five inferences:

3.1. Key Role of Knowledge Management and Tacit Knowledge: As Choo (1996: 329-340) classified, organization uses knowledge strategically in three arenas:

- To make sense of change in its environment;
- To create new knowledge for innovation;
- To make decisions about courses of action.

These processes are closely interconnected and could be managed to design a *"knowing organization"*. From this perspective, for knowledge to be of value it must be focused, current, tested, shared and managed. In one sense, knowledge has been managed at least since the first human learned to transfer the skill to make a fire. But, in new century, knowledge management is more than a necessity for organizations like Turkish Land Forces, whose principal currency is knowledge rather than physical and financial resources. Nevertheless, it remained the most neglected asset for a long time. Now, however, little managers across the Turkish Land Forces are realizing that the knowledge management concept must be taken to a higher level. But it can be hopefully stated that researches in this topic will make Turkish Land Forces and other knowledge-based organizations realize how important it is to *"know what they know"*. Without this asset and without any sort of tool for knowledge management, organizations are simply not equipped with a vision to foresee or to imagine the future and will never be promoted to *"knowing organization".*

Central to current concerns is the issue of knowledge management in project

since they have evident characteristics. First, a project is a unique task that is no one has been trough it previously. Second, a project is designed to attain a particular result. Third, it is limited in time. And finally, it requires a variety of resources. Thus, knowledge (especially tacit knowledge) in a project is unique, specific and non-repetitive.

Project teams are more intractable from a knowledge management point of view than individuals. However, the knowledge of how and why they created, what they created is more difficult to get at than an individual's knowledge, since it exists in a number of different people, and also in their continuous interaction, a small proportion of which is usually recorded. If 40% of the tacit knowledge overlaps in a new project, it can easily expressed that a significant base is formed.

In our experience, it was observed that during the project period our virtual team, by its very nature, created and used up a great deal of new knowledge, which was of high value to each MRG member. Such an accumulation could not be accomplished without a web-based tool. It can be confessed that we needed to become experienced at converting tacit knowledge into explicit knowledge that could be used by prospect project teams as a source of competitive advantage. But, there were some additional reasons:

- MORN was not designed to capture and automatically add to organizational memory whatever learning and the interactions of the users.

- MRG members indicated their tacit knowledge in e-mail messages rather than in MORN. So, it was concluded that; *"MORN should invoke the mail system directly".* Simple e-mail system should be organized within software so that it is filed automatically by the topic contained within the subject line.

3.2. Barriers of Organizational Memory: From the perspective of organization, one method of managing its intellectual resources is to attempt to augment its organizational memory, which records the accumulated knowledge with the purpose of supporting the continuous enhancement of knowledge-intensive work practices. In this respect, an organization should retain some knowledge of its past efforts and environmental conditions. Thus, there is no doubt that organizational memory systems as a specific knowledge management method and tool, is intrinsically linked with organizational learning and continuous process improvement. So, it can be suggested that the existence of an organizational memory system in a project group or throughout the organization seems to be crucial in the information era characterized by poorly predictable changes.

It can be concluded that the barriers defined in the literature partially conform to our findings from the field study. To summarize, barriers to an effective organizational memory system fell into two categories, cultural and technical.

The cultural barriers included the followings:

- A cultural emphasis on artifacts and results to the exclusion of process: In one sense, Turkish culture is an *"artifact-oriented"* culture; that is we appreciate results rather than relationships. In spite of trying to embrace tacit knowledge by effective use of MORN facilities, the result was not so cheering since only 10 % of the all entries were related to tacit knowledge.

- Since our team was established on the basis of knowledge sharing, neither *"the fear of loss of privacy",* nor *"the anxiety of loss of job security"* was observed.

- Resistance to knowledge capture because of the effort required: MORN required some additional documentation effort to preserve the context of the documents. The context of the social interactions must have been keyed into the system. This manual work was a considerable barrier standing in front of the project's corporate memory. The team might have made use of other MORN's facilities in passing through this obstacle; but from this point of view, our team was not so successful.

- Resistance to knowledge reuse because of the effort required: Users needed to search thorough the nodes in the system. But, this was not perceived as a serious handicap. As a matter of fact, some technical issues rather than cultural reasons caused a slight resistance. Because the initial usage was relatively low, users were in trouble in finding the sufficient content. But, afterwards this barrier was overcome due to attaching new nodes to the system.

- The low probability of finding relevant knowledge: Especially at the initial stages of the project, some users entered their knowledge with a considerable delay. In one respect, this caused a problem of losing relevance over time.

The technical barriers noted as follows:

- How to make the knowledge capture process easy or even transparent: MORN allowed users to upload the contents of the nodes and has been designed to store any sort of objects: abstract or concrete.

- How to make retrieval and reuse easy or even transparent: Searching capability of MORN in a variety of parameters was perceived as the most attractive feature of the software. In our experience, the issue was not proportionate with the tool. Technical infrastructure such as the capacity of ISPs, computer configurations of members, telecommunication infrastructure all around Turkey caused searching and even, log-in efforts to be quite slow.

- How to guarantee relevance of knowledge: The advanced facilities of MORN, such as filtering, sorting and assigning keyword mechanisms allowed

the users to reach the pertinent knowledge in an organized manner. Also, MORN Project was organized into sub-projects according to their scope areas. As described above, to ensure the relevance and to enhance the interaction between sub-projects, all of the sub-projects were collaboratively clustered. It was agreed that keeping nodes of different projects in different clusters and assigning some nodes as common provided an effective utilization throughout our virtual team.

- Cost of installing and maintaining the system: since MORN was already under construction, such a problem was not the case in our experience. The only cost of our virtual team was the outlays of connecting to Internet.

As zoomed above, in spite of the problems encountered during the MORN Project, most of the barriers to organizational memory have been passed over. For all its potential, a certain way to tap the value in an organization's particularly tacit knowledge could not be found. There is no doubt that creating an effective organizational memory system requires creating new tools and new practices, making changes in technology as well as culture. But all of the team members are convinced that MORN technology is so malleable that there is really no limit to what can be done. It is expected that MORN will continue to evolve as users and technical staffs become more familiar with the current capabilities and as information system technology expand. In short, the study found that augmenting organizational memory was possible, but it also uncovered a number of interesting issues and problematic design assumptions.

3.3. Virtual Teams in Distributed Project Management: Project management is a distributed activity involving different people with various roles and backgrounds from different locations. Moreover, projects crossing the boundaries of organizations have become frequent not only in research settings but also in the industry.

A central dilemma in an organization of dispersed projects is project efficiency versus effective project communication. Virtual teams are hailed as the answer to these problems. In the light of our experience, a checklist for virtual teaming were prepared, which, we hope, will serve as a base for similar studies:

- Assess the team's readiness for technology teaming.
- Identify activities that are most suitable for electronic teaming.
- Develop a plan for training and technical support.
- Determine the scope, content, and format for electronic teaming.
- Encourage experimentation among the team for getting them comfortable with the new technologies.
- Retain email messages for group memory.

- Archive team documents in email messages, or in an accessible database.
- Develop a system for identifying and labeling working versions of documents, final documents, and outstanding issues.
- Summarize all team members' ideas into working documents.
- Exchange working documents among team members for editing.
- Track outstanding issues that need to be resolved.
- Review all final documents and activities as a team.

Analysis also suggests that virtual teams need the same things all teams need: *"a clear mission", "an explicit statement of roles and responsibilities", "communications options which serve its different needs",* and *"a corporate memory".* The job of the manager of a virtual team is to create ways to make the working of the virtual team visible to itself.

It can be concluded that virtual teams will be a common way of project. In the era characterized by boundless in collaboration, knowledge-based and distributed organizations like Turkish Land Forces have to make use of the advantages that virtual teaming offer. In our consideration, it is time to stop thinking of them as a specific case and start developing strategies for dealing with the new challenges they cause.

3.4. Technical Issues versus Cultural Issues: In fact, organizational memory is not about just technology. It is basically a multi-disciplinary concern. Our study confirmed that while the technology must be very good, a shift towards a process-oriented paradigm must be realized in an organization. But, this requires organizational commitment and change of culture. And it is the most challenging part of establishing organizational memory and learning in an organization

Generally speaking, investments in information technology seem to be unavoidable in order to *"shape the future".* It can be proposed that the best way of applying information technology to knowledge management and organizational memory is probably a combination of two factors:

- The *"awareness of the limits"* of information technology and of the fact that any information technology deployment will not achieve much, if it is not accompanied by a global cultural change toward knowledge values;
- The *"availability"* of information technology. Managers have to look at what's going to happen next with the information technology and have some plans since knowledge evolves.

Web-based information technology applications either on Internet or Intranet (as exist but not so effective in Turkish Land Forces) might provide the basis for a *"neural system"* that could be used to implement the capacity for organizational memory. In MORN Project, some significant infrastructure problems relevant to easy access to Internet and consequently MORN were

faced. This highlighted that networking infrastructure both at the level of organizations and at the level of any sort of projects should be integrated to planning phase at the outset of the projects. Nevertheless, it can be doubtlessly stated that the advantages of geographical distance were overcome by MORN.

One more discovery was that using concept/attribute applications instead of data-rich ones are more effective for fostering collaboration and information sharing in R&D projects. This approach should be selected when content and scope of stored knowledge are unknown or extremely rich as well as when more qualitative information has to be stored and organized. Finally, this approach seems as the crucial point for especially large distributed organizations like Turkish Land Forces. In field study, MORN Knowledge System Methodology, which is thought to be worthy and useful as integrated with other existing methods in Turkish Land Forces was used in a small scale.

As outlined above, all members of MRG were active participants to design process of MORN. Thus, the study indicated that, on the content of requirement engineering, the requirement analysis of software should not only address the functional capabilities; but also, more importantly, focus on the practical usability of the system. To tell the truth, some technical issues regarding the design of MORN during the project were discovered. Software design team corrected many of them and a considerable proportion is waiting to be solved.

Within the confines of the field study, MORN *"worked",* and enabled cross-functional collaboration and interdisciplinary interaction among project members. From the view of technical implications, the study indicated that MORN technology, integrated with web and Internet technologies, has reached a stage in which it provides the desired functionality for developing a *"collaboration layer"* for connecting distributed R & D projects. In fact, MORN is not a radically new kind of system. In brief, it shows how a relatively simple combination of well-known concepts can provide a surprisingly powerful platform for a new kind of cooperative work application.

3.5. Role of collaborators: By representing the knowledge explicitly within an associative network, team members obtained a higher level of understanding for the actions, causes, and events that occur within this domain. This higher level of understanding allowed the users to reason more completely about problems and to develop better explanations and solutions. To us, collaborative discovery and discussion phase of model construction became an effective approach with suitable methods such as meetings (either face-to-face or electronically) or questionnaires.

It has been observed that the MORN and e-messaging were not a means to replace face-to-face communication, but motivated carrying more formal way

of problem definition and exploration. The design allowed for the production of knowledge on demand; it grew where users needed information. Since the major elements of the system are *"people",* it is expected that analysis following such kind of experiments may discover new findings about human behavior and cognitive efforts that may lead to a better system design.

4. SUGGESTIONS FOR FUTURE RESEARCH

The above approach to capture organizational memory and to manage virtual project process has its limitations. First, the analysis was limited to the group level. Second it was a short-term work so it relied primarily on short-term payoffs. In is likely that deciding whether such a system is sufficient with its facilities requires long-term studies. Third, the field study examined only use among military individuals who accomplished R&D studies in a virtual team environment. So generalizations to groups with different careers seemed unclear. Future researches can address certain limitations of the present study.

The study was "*descriptive"*, and we have only scratched the surface of an area that we believe useful to further researches. However, many issues still remain open. Social barriers to capture organizational memory in Turk culture should be explored in depth. One more point, examining the integration of MORN in conjunction with existing tools should be the next step.

Turkish Land Forces as a distributed organization and a knowledge-oriented organization since its establishment has to make use of the advantages that both organizational memory systems and virtual teaming offer. While technical mechanisms of MORN offer great potential for this point of view, proof must await field studies of its use. The results from the study can be used to further refine the system. At this point, the future is practically assured, as the MORN grows in content and functionality, and the usage continues to increase.

To conclude, we can argue that web-based knowledge management tools like MORN should move from the *"nice to have"* to the *"must have"* category for successful organizational memory and virtual team applications.

ÖZET

Literatürde bilgi teknolojilerinin ve özellikle “Kurumsal Hafıza” sistemlerinin organizasyonları nasıl desteklediğini ortaya çıkarmaya çalışan pek çok çalışma vardır. Maalesef, literatürde kurumsal hafızanın önündeki engelleri irdeleyen araştırmalar yetersiz kalmış ve ancak 1990’ların ikinci yarısından sonra ilgi çekmeye başlamış, hatta bu konuda ampirik çalışmalar hemen hiç yapılmamıştır. Kanımızca, bugüne değin Türkiye’de kurumsal hafızayı engelleyen kültürel ve teknik handikaplar dikkat çekmemiş bir konu olarak ortaya çıkmaktadır. Yine eş zamanlı proje yönetimi çerçevesinde dağınık proje üyelerinin etkileşimini amaçlayan ampirik çalışmalar son derece yetersizdir. Belirtilen son derece kısıtlı teorik altyapıya rağmen, bu konu araştırma yapmak için bize yeterince olgunlaşmış görünmüştür.

Bu çalışmada, sınırlı teorik bilgiyi kendi teorilerimizle birleştirmek ve teorik konseptleri pratik uygulamalara dönüştürmek amaçlanmıştır. Bu nedenle, eş zamanlı Ar-Ge projelerinin yönetilmesinde, web tabanlı bilgi

yönetimi ve kurumsal hafıza sistemlerinden biri olan "MORN Bilgi Sistemi" kullanılarak bir saha incelemesi yapılmıştır. Araştırmada, ASAG (Askeri Araştırmalar Grubu) bünyesindeki 10 Ar-Ge projesi alt projeler olarak ele alınarak, MORN Projesi olarak adlandırılan bir "dağınık" (coğrafi ve entelektüel) Ar-Ge Projesi uygulaması yapılmıştır. 5 aylık sürede MORN'un kullanılabilirliği sorgulanarak her türlü iletişim gözlemlenmiştir. Bu amaçla; MORN Bilgi Sisteminin, kurumsal hafızanın tesisine ve engellerin aşılmasına muhtemel katkılarına özellikle dikkat edilerek, kullanıcılar tarafından algılanan faydalarına odaklanılmıştır. Ürün ve süreç aynı anda geliştirildiği için eşzamanlı mühendislik uygulaması kapsamında tüm proje üyeleri MORN'un tasarım sürecine aktif olarak katılmışlardır.

Çeşitli anket uygulamalarının yanı sıra, saha gözlemleri, mülakatlar vb. yöntemler kullanılmış, veri analizi "tanımlayıcı" bir tarzda gerçekleştirilmiş, temel istatistik verileri ise sonuç çıkarmaktan ziyade çalışmayı "resmedici" bir yaklaşımla ele alınmıştır.

Araştırmanın sınırları dahilinde MORN'un alt proje yöneticileri arasında disiplinler arası ve çok fonksiyonlu işbirliğini desteklediği söylenebilir. Bir başka sonuç ise, web ve İnternet teknolojileri ile entegre olmuş MORN teknolojisinin dağınık projeleri birleştiren bir fonksiyonelliğe ve esnekliğe ulaşmış olduğunun tespitidir. Tüm potansiyele rağmen özellikle informel bilgilerin değerlendirilmesinde kesin bir çözüm yoluna ulaşılamamıştır.

Literatürde bahsedilen kurumsal hafıza engellerinin, bizim uygulamamızla kısmen örtüştüğü ulaşılan sonuçlar arasındadır.

Araştırma; "tanımlayıcı" (diskriptif) ve belki bir bakıma da MORN'un tasarımı gerçekleştirildiği için "kural koyucu" (prediskriptif) olarak tanımlanabilir. Bu ve bunu takip edecek araştırmaların ışığında organizasyonların kurumsal hafızalarının etkin bir şekilde tesis edilebileceği umulmaktadır.

References

Abecker, A., Bernardi A., Hinkelmann K., Kühn O and Sintek M., (May/June, 1998), *"Toward a Technology for Organizational Memories",* IEEE-Intelligent Systems, 40-48.

Ackerman M.S. and Halverson C., (November 1998), *"Considering an Organization's Memory",* ACM Conference on Computer-Supported Cooperative Work (CSCW'98). Also at http://www.ics.uci.edu/~ackerman/pub/98b24/cscw98.om.html

Ackerman M.S., (January 1994), *"Definitional and Contextual Issues in Organizational and Group Memories",* Organizational Memory minitrack, 27th Twenty-seventh Hawaii International Conference of System Sciences (HICSS), p.: 37-49. Also at http://www.ics.uci.edu/~ackerman/docs/hicss94/hicss94.html

Ackerman M.S., (July 1998), *"Augmenting Organizational Memory: A Field Study of Answer Garden",* ACM Transactions on Information Systems, Vol. 16,203-224. Also at http://www.ics.uci.edu/~ackerman/docs/cscw94/cscw94.html

Amidon, D.M., (Updated in 1999), *"Evolution of Thought: Timeline",* http://www.entovation.com/timeline/timeline.htm

Andersen, E.S., Grude, K. and Haug, T., (1995), *"Goal Directed Project Management",* Second Edition, Coopers and Lybrand, London, U.K., p.: 1-94.

Appelt, W., (February 1996), *"CoopWWW-Interoperable Tools for Cooperation Support using the World-Wide Web",* Proceedings of the ERCIM workshop on CSCW and the Web, Sn. Augustin, Germany, Also at http://orgwis.gmd.de/projects/WAG/proceedings/coopwww.html

Argyris, C. and Schon, D., (1978), *"Organizational Learning: A Theory of Action Perspective",* Reading, p.: 31-32.

Başoğlu, A.N. and Öner, M.A., (July 1999a), *"MORN: Multimedia Object Relation Network; A Knowledge System to Support Research Projects"*,

Proceedings-PICMET'99, Portland International Conference on Management of Engineering and Technology, Portland, Oregon-USA.

Başoğlu, A.N. and Öner, M.A., (August, 1999b), *"Modeling Research Idea on Web Using MORN Platform"*, Proceedings-ISAS'99, 5th International Conference on Information Systems Analysis and Synthesis, Orlando, Florida-USA. Also Proceedings-SCI'99, Third World Multiconference on Systemics, Cybernetics and Informatics (SCI'99), Orlando, Florida-USA.

Başoğlu, A.N.; Öner, M.A.; Özkan İ. M.; Özer, S.; Güngör, Ö.; Tiregöl Z., (Eylül, 2000), *"Araştırma Projelerinin Web-Tabanlı MORN Platformunu Kullanarak Yönetilmesi"*, 17 nci TBD Bilişim Kurultayı, İstanbul.

Borghoff, U.M. and Pareschi, R., (1999), *"Information Technology for Knowledge Management", J*ournal of Universal Computer Science, Vol. 3, Issue 8, p.:14-16. Also at http://www.iicm.edu/jucs_3_8/information_technology_for_knowledge/paper.html

Chan,F., (1998), *"Web-Based Project Management Application"*, DARPA, http://ilpsoft.eecs.berkeley.edu:9636/~ilpsoft/abstracts/fcham.1.html

Choo, C.W., (October 1996), *"The Knowing Organization: How Organizations Use Information To Construct Meaning, Create Knowledge, and Make Decisions",* International Journal of Information Management, Vol. 16 No.5, 329-340. Also at http://choo.fis.utoronto.ca/FIS/ResPub/KOart.html

Conklin, E.J., (1996a), *"Capturing Organizational Memory"*, Proceedings of GroupWare'92, USA (1992). Also White Paper at Group Decision Support Systems, Washington, USA, http://www.gdss.com/Corganizational memory.htm
Conklin, E.J., (1996b), *"Designing Organizational Memory: Preserving Intellectual Assets in a Knowledge Economy",* White Paper at Group Decision Support Systems, Washington, USA, p.:21-22, http://www.gdss.com./Dorganizational memory.htm

Davenport, T.H., (1999), *"Some Principles of Knowledge Management",* White paper, p:9, Information Technology Management Website, http://www.itmweb.com/essay538.htm

Dennis, A., (1996), *"Groupware on the Web",* http://tcbworks.cba.uga.edu/~adennis/tcbreeng.htm

Ertürk, S., (1999), "*Information Exchange Needs In Supply Chain Management: Managing Risk In Military Acquisition System"*, Unpublished Master of Science Thesis, Yeditepe University, İstanbul, Turkey.

Farquar, A., (December, 1995), "Building Global knowledge Webs: Knowledge representation for the Web", Position Paper, p: 4, Panel Session at The 4th International Conference on The WWW, Boston, USA.

Fraenkel J.R. and Wallen, N.E., (1996), *"How To Design and Evaluate Research in Education"*, McGraw-Hill,Inc., USA, 3rd edition, Chapter 18, 416.

Iyigun, İ., (July 1999), *"Multiproject Management System Implementation",* Proceedings-PICMET'99, Portland International Conference on Management of Engineering and Technology, Portland, Oregon-USA, p.: 67-69.

Kimball, L., (1997), *"Managing Virtual Teams",* Text of speech in Team Strategies Conference, Toronto, Canada, p.:17-79.

Liao, M., Hinkelmann, K., Abecker, A. and Sintek, M., (1999), *"A Competence Knowledge Base System as Part of the Organizational* Memory", http://www.iicm.edu/jucs_3_8/corporate_memories_for_knowledge.html

Malhotra, Y., (July/August, 1998), *"TOOLS@WORK: Deciphering the Knowledge Management Hype",* Journal for Quality and Participation, Special issue on Learning and Information Management Vol. 21, No. 4, 58-60. Also at

http://www.brint.com/km/whatis.htm

Murray, P.C., (1999a), *"What to Know Before You Select Knowledge Management Technology",* http://www.ktic.com/TOPIC7/14_TECH.HTM

Murray, P.C., (1999b), *"Information, Knowledge, and Document Management Technology",* http://www.ktic.com/TOPIC7/12_INFKM.HTM#e102265

Nevis, E., DiBella, A. and Gould, J., (1995), *"Understanding Organizations as Learning Systems",* Sloan Management Review, winter, 73-85.

Newman D.B., (March, 1996), *"The Knowledge Management Forum",*An Open Discussion, http://www.3-cities.com/~bonewman/what_is.htm

Nonaka, I. and Takeuchi, H., (1995), "*The Knowledge Creating Company",* Oxford University Press, USA, p.: 44-45.

Öner M.A., Başoğlu A.N. and Türe E., (July 1999), *"Technology and Rural Development: Assessing Technology Needs of the Southeastern Anatolia*

Project in Turkey", Proceedings-PICMET'99, Portland International Conference on Management of Engineering and Technology, Portland, Oregon-USA.

Paper, D. and Johnson, J., (1996), *"A Theoretical Framework Linking Creativity, Empowerment, and Organizational Memory",* Proceedings of the 29th Annual Hawaii International Conference on System Sciences, Vol. IV, Los Alamitos, Cuba, 20-33.

Sekeran, U., (1997), "Research Methods for Business: A Skill-Building Approach", John Wiley and Sons, Inc., USA, 2nd edition, Chapter 8,239-244.

Senge, Peter, (1990), "*The Fifth Discipline: The Art and Practice of the Learning Organization*", Doubleday Currency, New York, USA, p.:76.

Skyrme, D.J., (1997), *"From Information to Knowledge Management: Are You Prepared?",* p.:14, http://www.skyrme.com/pubs/on97full.htm

Sveiby, K.E., (1997), *"Tacit Knowledge",* http://203.32.10.39/Polanyi.html

Thamhain, H.J., (July 1999), "*Emerging Project Management Techniques: A Managerial Assessment",* Proceedings-PICMET'99, Portland International

Conference on Management of Engineering and Technology, Portland, Oregon-USA, p.:114-129.

Walsh, J.P. and Ungson, G.R., (1991), *"Organizational Memory",* The Academy of Management Review, Vol. 16(1), 57-91.

Wieranga, R. J., (1996), Requirements Engineering-Frameworks for Engineering, John Wiley & Sons, Inc., USA, 1st edition, p: 48-75.