Information System Analysis for a Large Construction Firm: A Case Study in Turkey

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Abstract: The subject of this paper is an information system (IS) analysis study for a Turkish contracting firm realizing large scale projects both in Turkey and abroad. The first purpose of this paper is to expose the conceptual framework of the IS analysis approach stated above and method in detail, and the steps and the tools used to do an IS analysis in a contracting firm. The relevant literature tells about numerous strategies and methods directed to IS analysis and development. However, most of these methods are not handled from the operational aspect. Therefore, the authors hope to make a contribution to this area with this paper that explains the system analysis process from the operational point of view. The second purpose is to explain the problems encountered by the authors in the implementation of the method and share the experience gained by the study and thereby contribute to debates concerning methodology related to IS analysis in construction firms. Finally, the third purpose is to expound the problems of the existing IS used by the contracting firm and thus establish the main points that should be kept in mind during IS analysis and development in contracting firms.

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Abbreviations

ADS Accurately Defined Systems
A/E/C Architecture/Engineering/Construction
DFD Data Flow Diagrams
DPData Processing
IPO Input-Process-Output
IS Information System
ISAC Information Systems Work and Analysis of Changes
ISASA IS Analysis by System Approach
IT Information Technology
MIS Management Information System
SIS Strategic Information System
WBS Work Breakdown Structure

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Introduction

Different market forces, current and emerging information technology (IT) capabilities such as communication, data accessibility and common systems, affect the design and construction firms that play a major role in the construction sector. These effects result in increased integration, increased inter-dependence and inter-relatedness, inter-organizational business relationships, intra-organizational coordination and adaptable organizational structures, i.e., networks and clusters. The changing business environment and increased IT capabilities are translating into a more focused emphasis on integration [1].

Today, there is a lot of software developed especially for the in-house functions of construction firms. However, this software cannot answer all the different requirements of all construction firms, does not have enough flexibility to meet the changing condition of firms and is not designed according to the relations between different functions. In other words, in most cases, integration among functions cannot be accomplished.

Another solution for IS requirements is to integrate commercially available software packages. Integrating commercially available software is considered sometimes a more reasonable solution than developing the model from scratch. The reasons and enabling technologies for using such packages are explained clearly by Rao et al. [2]. There are also comprehensive models that define the architecture of construction-related software integration (e.g., Fischer and Kunz [3], Wu and Hadipriono [4]). The idea of managing efficiently the functional components of a construction company or a design firm by means of computer applications is not new. Various systems are reported in the literature that attempt to solve the integration problem; examples include RATAS - Infrastructure for Computer Integrated Construction [5], SPACE - **S**imultaneous **P**rototyping for **a**n Integrated **C**onstruction **E**nvironment [6], I3CON - **I**ntelligent **I**ntegration of **I**nformation in **Con**struction [7], COMMIT - **Co**nstruction **M**odeling and **M**ethodologies for **I**ntelligent Information In**t**egration [8], COMBINE - **Co**mputer **M**odels for the **B**uilding **In**dustry in **E**urope [9], ASAP – **A**utomation **S**ystem for **A**rchitectural **P**ractices [10], ASCC – **A**utomation **S**ystem for **C**onstruction **C**ompanies [11] and MITOS – **M**ulti-phase **I**ntegrated Au**to**mation **S**ystem for A/E/C Firms [12]. Although these are comprehensive studies in the area, most of the models developed are reference models.

Current information modeling for the A/E/C (architecture/engineering/construction) industry includes *product, process*, and *project* models [13]. *Product models* are conceptual structures used to organize and communicate building product information among project participants. They contain product information such as the properties of its parts, including geometry, topology, composition, material, behavior, etc. [14]. *Process models* represent the important steps throughout a project's lifecycle. *Project models* provide a framework for system integration of product, process, and organizational aspects for A/E/C projects to provide richer semantics for project management. Froese [15] introduces several versions of core conceptual models (reference models) of construction processes from a variety of research projects associated with computer-integrated construction. Core models are intended to be high-level models that provide a unifying reference for more detailed application models and their role for A/E/C is to provide a unifying reference from which to construct *application models* for use within specific areas of project management. As integration capabilities continue to improve, the collected integrated systems reach a critical mass where they can form the primary mechanism or media used to develop, record, work with, and communicate the overall body of project information. These systems are called *Total Project Systems* [16].

In summary, although, due to known reasons stated by Brauer and Fischer [17], AEC firms are in need of significant information handling requirements, they are unable to use opportunities provided by IT to the full extent and efficiently. On the other hand, IT and IS are constantly going through an evolution and development process.

Ward and Griffiths argue that IS/IT, and their existence in the organizations, underwent a great change from the early 1960's to 1980's. The objectives of IS and IT vary in each era [18]:

- The Data Processing (DP) era aims at increasing operational efficiency by automating the processes based on information.
- The Management Information System (MIS) era aims at increasing management effectiveness by meeting the information requirement of mid-level management staff.
- The Strategic Information System (SIS) era aims at increasing the competitiveness by changing the management or nature of the business.

Ward and Griffiths have exposed trends in the evolution of business IS and IT by examining the characteristics of each era according to the nature of technology, nature of operations, issues in systems development, reasons for using technology and characteristics of systems.

Apart from that study, Sullivan has pointed out the powers outside the control of the organization affect the planning environment of the IS and IT [19]. Sullivan has classified organizations as *opportunistic*, *complex*, *traditional* and *backbone* according to the effects of such powers. As also pointed out by Sullivan, IS and IT can acquire different structures in different organizations as a result of the effects of environments.

When looking back at development history of IS, it is observed, especially recently, that IS has to be suitable to the strategic goals of the firms, i.e., basically, it has to be designed so as to support the strategies of the firm. The fact that each firm has to have different strategies according to its relevant environmental conditions, brings about the necessity for these firms to structure their IS to suit these different strategies. This situation shows that in the long term, IS analysis and development will be an ongoing need of contracting firms in the construction sector just like it is with firms in other sectors.

Approaches to and Methods for IS Analysis

In its general sense, in the relevant literature, there are numerous sources and methods related to the function of IS planning, which consists of two main phases, namely IS analysis and IS development. In literature, context wise, IS analysis can be explained as the information requirements determination or the information needs analysis.

As it is well known, an information system should meet the needs of the host organization it serves. The requirements for the information system are thus determined by the characteristics and procedures of the organizational system. However, correct and complete information requirements are frequently very difficult to obtain. Simply asking prospective users of the information systems to specify the requirements will not suffice in a large percentage of cases.

The reasons for the difficulty in arriving at correct and complete requirements for information systems suggest that there cannot be a single approach to requirements determination that is applied to all projects [20].

A strategy can be defined as an approach for achieving an objective. Strategies are general approaches. A method is defined as an orderly or systematic procedure. A methodology is a set of methods and techniques. Methods and techniques are detailed means of undertaking the strategies.

There are four strategies for determining information requirements [21]:

- Asking.
- Deriving from an existing IS.
- Synthesizing from characteristics of the utilizing system.
- Discovering from experimentation with an evolving IS.

For each strategy, there are a number of methods and methodologies that differ in the amount of structure provided. Some provide conceptual structure, but little process and documentation structure; others provide detailed structure for all tasks and all documentation.

Several methods have been proposed for performing information requirements determination:

- **Normative analysis methods** are based on the fundamental similarity of classes of object systems; these fundamental characteristics lead to a prescribed or normative set of requirements [22].
- **Strategy set transformation** methodology is primarily for obtaining organization-level information requirements that are derived from the objectives of organization [23].
- **Critical factors analysis** is a method for eliciting the significant decision or other factors that can be used in deriving information requirements [24].
- **Process analysis** focuses on business processes (groups of decisions and activities required to manage each of the resources of the organization). An example of this methodology is Business System Planning (BSP) [25].
- **Decision analysis** has been shown to be very useful in clarifying the information requirements with users in cases where the decision process is fairly well defined [26].
- Socio-technical analysis is oriented to application-level analysis and consists of two parts: social and technical analysis [27].
- Input-process-output analysis is a system approach. The advantage of analysis based on inputs, process, and outputs of systems is that it is systematic and comprehensive. Examples are ISAC - Information Systems Work and Analysis of Changes, DFD - Data Flow Diagrams and ADS - Accurately Defined Systems, ISASA – IS Analysis by System Approach [28, 29].

Subject, Goals and Organization of the Paper

The subject of this paper is to explain the methodology and findings of an IS analysis study carried out by the authors of this paper for a contracting firm realizing large scale projects both national and international.

The first aim of the paper is to state the method applied to analyze the information system of the contracting firm. This is necessary since the analysis methods are not mentioned in detail in the relevant literature. The lack of operational details in the application of the information system analyzing methods makes it necessary to help inexperienced analysts studying the problem. The method applied in this case study is explained in two steps. In the first step, the outline of the method is stated in general; and in the second step the details of the study are given.

The second aim of the paper is to explain the problems confronted in the application of the method. Thus, it is hoped that the feedback information about the application of the method will help to verify the theory and assumptions of the method applied. These issues are discussed in the section “Problems Encountered During System Analysis Study” later in this paper.

The third aim of the paper is to present the findings of the system analysis study applied, and to evaluate these findings in a systematic way. The authors observed that many of the other contracting firms had the same kind of problems as the firm analyzed. That is why the majority of this type of organizations might utilize the findings of the study. These issues are discussed in the section “Findings of the System Analysis” later in this paper.

The fourth aim of the paper is to reach some solutions to solve the problems noted in the information system analyzed, and to make suggestions that can be applied by the contracting companies that have from the same problems. These issues are discussed in the section “Conclusions and Recommendations” later in this paper.

The Outline of the Information System Analysis Method Used

Two basic methods were applied concurrently in the analysis of the information system of the contracting firm. The first one is the “Asking Method”. In the asking method the analyst obtains information requirements solely from persons utilizing the system by asking them for their requirements. The personnel of the firm are asked what functions they are responsible for are; what their expectations from the information system are; what the information they require for the

stated function, from where they obtain the required information and to whom they send the output of their operations, etc.

The second basic method used in the analysis of the information system of the firm is the **Input-Process-Output** (IPO) method that means system approach. Using this method the activities in the information system were analyzed. Sub-systems are then analyzed in the same way down to the level at which information processing appears as an activity. The information system activities are analyzed as systems and sub-systems using graphs and tables. The tools used in the application of these methods are *job definition forms*, *structure models*, *input information tables*, and *output information tables*.

The Details of Information System Analysis Applied in the Firm

Basic Steps of System Analysis Study

The basic steps in the analysis of information systems realized by the concurrent use of the both methods stated above are given in Figure 1. The details of these steps are explained below.

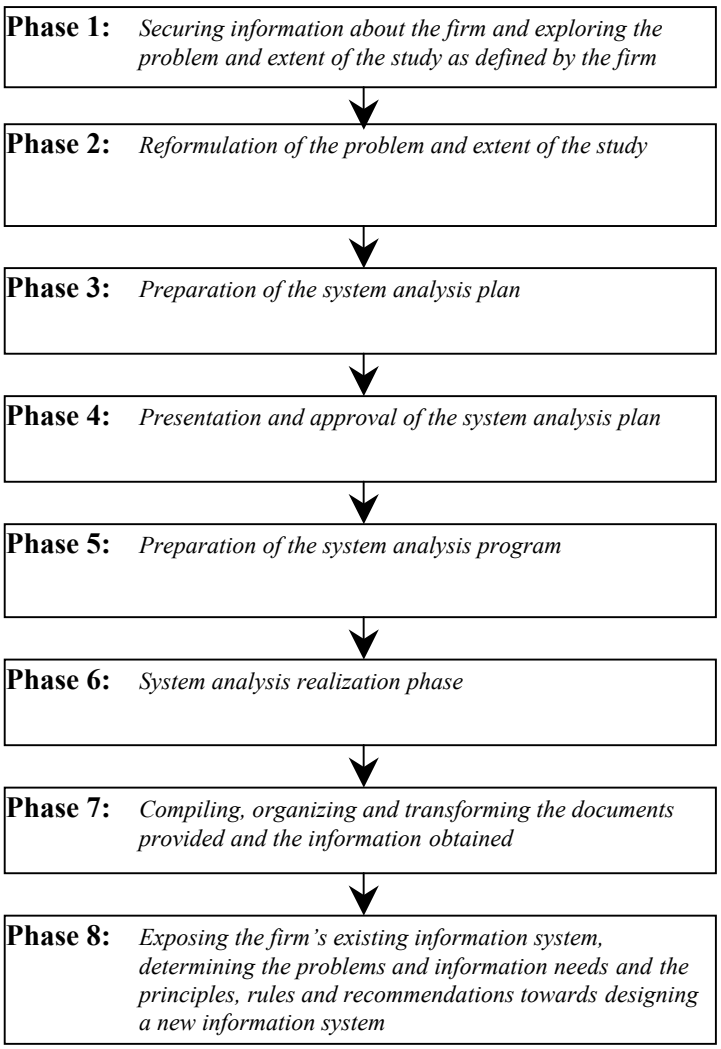

Figure 1. Basic steps of system analysis study

Phase 1 Securing information about the firm and exploring the problem and extent of the study as defined by the firm

At the onset the contracting construction firm summarized the problems and scope of the study. In order to explore the scope and objectives of the study as formulated above by the firm, and also as a requirement of the system approach, the work group requested additional information to help perceive the firm as a system. In the light of the information received, the firm was found to have the following basic features:

- The firm is a construction contracting company within the framework of a holding company dealing in various fields. The organization of the headquarters consists of assistant managers directly responsible to a general manager working under a board of directors. The assistant general managers are the managers of the main functional areas and the product (project) groups. The organizational chart is devised so as to provide an organizational division based on function and product.
- The firm has sites both at home and abroad. Each assistant general manager at the headquarters is responsible for one site at home or abroad.
- The firm has undertaken projects in Libya and Russia and is making contracts on a cost-plus fee and lump sum basis for sites at home and abroad.
- Unlike sites at home, the sites abroad are decentralized. The headquarters provides only logistic support to sites abroad. Therefore, the sites at home are more dependent on the headquarters.
- The firm also has tunnel mould, steel mesh and carpentry installations that function as independent firms giving support to the construction activities.
- The work group has determined the following shortcomings when comparing the information received from the firm with the scope of the study as determined by the firm at the beginning of the study:
- It is impossible to develop a general site IS to be used in the existing and possible future sites of the firm based on analysis conducted only on the site for which a system analysis is requested by the firm, because there is a continuous exchange of information between headquarters and the sites. Therefore, a study and system analysis has to be carried out at the firm's headquarters as well.
- A study and system analysis has to be conducted in the other sites of the firm at home because the activities carried out in different sites are based on different contract types. There are cases where some functions at the sites are different and therefore the relations of these functions with the general site IS are different.
- It is unnecessary to include the sites abroad into the system analysis since they work on a decentralized basis.

Phase 2 Reformulation of the problem and extent of the study

In phase one, determinations made by the work group were evaluated in a meeting held with the persons appointed by the firm to develop the IS and with the authorized persons of the data processing department, and the problem and the scope of the study were re-defined.

At this meeting, it was mutually agreed by all concerned that the work group should make a system analysis and inspection, first at the various construction sites and then at the headquarters of the firm.

It was also decided that a “system analysis plan” be prepared by the work group and that this plan be presented at a meeting to be held with the managers of the headquarters and of the construction sites of the firm. The basic goals expected from this meeting were:

- to discuss and finalize the scope of the study and the system analysis plan advised by the work group.
- to allow managers to express their expectations from and their objectives regarding the IS more clearly.
- to convince all managers of the advantages provided by the new system and ensuring the

participation of all employees of the firm in this study.

Phase 3 Preparation of the system analysis plan

In this phase, the work group completed its work on the "system analysis planning". The basic elements of the resulting system analysis plan are as follows:

- The results of the previous two phases have been used to define the purpose, scope and limitations of the system analysis, and provide their rational basis.
- Personal interviews and record searches were used as the information gathering method. Questions to explain the existing and desired situation were addressed to the administrative and technical personnel in the firm.

The type of form to be used at the end of the interviews to record the information gathered were determined and these are listed below:

- "Job definition form" of the interviewer.
- "Input-output model" for the job performed by each employee.
- "Work flow diagrams" for each function.
- "Structure models" showing the sub-functions carried out within each function or job area defined in the organization as a whole on a single chart.
- "List of incoming information" to record its function in a certain area.
- "List of outgoing information" to record its function in a certain area of function and then deliver it to another area where the function is recorded.
- "List of hardware and software" used by the employees for tasks performed.
- General evaluation report related to the existing system.

Phase 4 Presentation and approval of the system analysis plan

In phase four, the system analysis plan prepared by the work group during phase three was presented for discussion in a meeting attended by the chairman of the board, the assistant general managers and the construction site managers of the firm. The work group explained the phases in the system analysis plan. As a result of the meeting:

- The system analysis plan was generally accepted and approved.
- It was expressed that there was nothing that might cause any difficulty in or hinder the performance of the works foreseen in the plan and that the plan was feasible.
- Those who attended the meeting said that they would hold meetings with the employees in their own areas of responsibility and explain the content and the benefits of this study to them and ask them to give support to the work group.

Phase 5 Preparation of the system analysis program

In phase five an analysis was performed within the general work schedule of the system analysis plan. During this phase, the organization charts of the construction sites A and B and the headquarters of the firm were used to make appointments for interviews. The interview schedule was sent to the construction site managers and the headquarters for their approval. The interview schedule was returned with some revisions made by those concerned, and work commenced according to the revised schedule.

Phase 6 System analysis realization phase

Interviews were held on the construction sites and in the headquarters of the firm in accordance with the interview schedule finalized during phase five. During these interviews, each employee was briefly informed about the objectives of this study and the method used. Questions were then asked and answers received. However, as some employees could not make all the documents concerning their area of function available, they were asked to furnish such documents to the work group later. When inconsistencies were detected in the gathered information, such information was arranged in forms, and the interviewed employees were asked to examine the forms and complete or correct any missing or inaccurate items.

Phase 7 Compiling, organizing and transforming the documents provided and the information obtained

During this phase, determinations made for the existing IS as a result of analysis studies conducted at both the construction site and the firm level were transformed into visual material by means of the system analysis tools identified in phase three. As a result of assessments made in this phase, the basic functional modules both at the construction sites and the headquarters were determined. Thus, the distribution of tasks and functions in the existing organization structure could be re-designed.

Phase 8 Exposing the firm's existing information system, determining the problems and information needs and the principles, rules and recommendations towards designing a new information system

In the last phase of the IS analysis the work group prepared a written report based on the findings of the previous phase. The results of these findings were evaluated on the basis of the main titles in McLeod's "General System Model for Firms" approach. Thus, the problems diagnosed in the 'management structure', 'performance standards' and 'information system', which are the three key elements of the conceptual system controlling the physical system of the firm, have been emphasized as the results of the findings under the aforementioned titles.

As already stated in the introduction, the said problems and results can only be given here in a limited way and as described in the introduction.

Problems Encountered During System Analysis Study

Technical and human-related problems encountered during the system analysis study can be summarized as follows:

- During interviews, it would be highly advisable for the interviewer to have a previously prepared job-function checklist. Such a checklist was not used in this study. Instead, the exactitude of the answers obtained was determined by cross checks with a superior and a subordinate of the relevant interviewee.
- Due to the nature of the construction business and high workload at the construction site, the interviews could be conducted only during the periods, which could be spared by the employees for this purpose. In many cases there was no opportunity to re-interview the same person.
- The fact that a firm does not have standards or strategic plans, which must be considered as an integral part of the existing IS, eliminates any possibility to evaluate the actual situations or results and thus diagnose the problems.
- Despite all explanations and clarifications made by the management, the employees had a legitimate concern that the study was being conducted to check their individual performance.
- In other cases, the interviewed individuals began to express their opinions about the project in the form of complaints, which caused difficulty in obtaining the required answers.
- A few employees in various positions, both at the construction site and the headquarters, conveyed a feeling that they considered this study unnecessary.
- Generally, no answer was obtained to the questions "What are the basic problems related to the function you perform?" and "What are the problems that cause failures in performing of your tasks?" since the interviewees perceived this analysis as an appraisement of their performance.
- The answers given to the question "Is there anything missing in the information supplied to you for better performance of your tasks?" were not satisfactory. This indicates that the busy work schedule, especially of employees working on building sites, gives them no time to discuss or think about the types of information input they need to perform their tasks better.
- The impression delivered by the employees working on the sites, in particular, is that they

are not really aware of the fact that an accurately installed and satisfactory IS would have a positive effect on their performance. Thus, during interviews, some employees clearly expressed that IS was only a heap of bureaucracy, and unnecessary.

Findings of the System Analysis

The findings of the system analysis are presented in three groups. Firstly, the structure of IS and IT is considered as it was described by the Ward and Griffiths scheme. Secondly, the effects of the planning environment of the IS and IT is determined. Lastly, the characteristics of the firm and its IS system are defined.

The First Group of Findings from the Perspective of the Five Characteristics Defined by Ward and Griffiths

Nature of Technology

The fact that this study was conducted in an era when SIS is gaining significance around the world is ultimately not of major importance. What is of importance is the era in which the firm is undertakes studies of its IS or IT.

Although the firm knows that its IS and IT must support the business, at least some managers think the opposite. This is evident in the definition of the problem provided by the firm. It indicates a discrepancy between conception and action. However, the firm requested this study to eliminate the said discrepancy.

The firm's approach to the existing IS and IT bears the characteristics of the DP era, although the most advanced hardware and software technologies are employed at the headquarters and the construction sites. The problem is that this technology is not used in line with the principles of MIS or SIS approaches. Although there is the possibility of using the IT in a SIS mode, consisting of integrated systems in the structure of MIS or network where the interconnected structure is essential, this technology is used with an approach of the DP era in the form of independent and not interconnected computers, and software with which integration is not possible.

Nature of Operations

Due to this technological structure, it is not possible for the users to implement the IS and IT with a large base to access the information in the system. None of the software or hardware enables the users, except for a few individuals, to access the system, and a user at a certain site of the system can access the information he needs only with the help of a staff member in charge. The system is far from the users who need the information, and therefore it reflects the approach of the DP era.

Issues in System Development

The main issue in the development of IS has been the performance of functions at the construction site level, that is the increasing of the operational efficiency, rather than gaining a competitive advantage in the business of the firm. This, in turn, is an MIS era IS approach which is, “an IS to meet user needs”.

Reason for Using the Technology

For reasons given above, it is not possible for IS and IT of the analyzed firm and sites to support the strategic objectives of the firm because they have not been designed to this end.

Characteristics of Systems

Due to the aforesaid structure of the IS and IT and the factors shaping this structure, the IS and IT employed by firm are for transactions, restrict the participation of the users, are rigid in a way to prevent participation, limit the functions and serve internal purposes only. With these characteristics, they are the IS and IT of the DP era.

The Second Group of Findings Related to IS and IT Planning of the Firm

When the various construction sites of the firm are examined, it is observed that at each site there are structures which arise from its particular conditions, are unlike the others and cannot be integrated with the others, are designed according to the local conditions, and are based on local priorities. This is quite natural because project characteristics, project delivery systems and the information demands of the client differ from one site to the other.

In the light of these determinations, the structure of the IS and IT of the firm can be defined as being in the *opportunistic* category. However, in some respects, when the internal IS which had to be established to obtain the required critical information supplied by the IS at the project level is taken into account, it can be said that the essential category should be the *complex* category. Since this structure is unsuccessful, a strategic IS support to ensure the firm's competitive advantage in business cannot be obtained.

Each construction site has developed an IS specific to its own conditions to provide information required by local parties such as the owner, the controller, the local administration etc., on the basis of the project carried out by that construction site. This configuration refers partly to an *opportunistic* and partly to a *complex* pattern. Because the firm is in need of information which must be provided by the construction site dimension of the essentially decentralized strategic IS, the firm fails when such information is not received; however, since there is no IS designed for this purpose, an *opportunistic* structure which does not take into account the requirements of the firm, and which is designed to serve the short term objectives and operational efficiency, can be mentioned.

The largest construction site of the firm in Istanbul is an extreme example in terms of the design and implementation of IS. Its information infrastructure has been designed to provide the reporting set up and demanded by the controlling body and to meet the requirements of the local parties, with constituents appended one after another as needed for local solutions, instead of being based on a holistic approach. Each department at the construction site usually uses general-purpose software and sometimes specifically developed software to produce, save and process the information expected from it; however, no correlation between them can be established due to the reasons specified above.

The Third Group of Findings Related to the Organizational Structure and IS Components

The firm has a computer-based information gathering and processing infrastructure both at the construction sites and at its headquarters. The constituents of this infrastructure are not integrated in respect of either hardware or software, and the firm does not have a systematic structure consisting of constituents integrated both in the conceptual and practical dimensions, in other words, the firm does not have a computer-based IS.

Since the computer-based information infrastructure at the various construction sites has not been taken into consideration as a whole from a conceptual point of view, it is not possible for the headquarters to merge, or compare the incoming information. As already mentioned, since each construction site established a system for its own purposes with an opportunistic approach the software used also makes it impossible for either the headquarters or the sites to access the information in the other's system. As an example, while different software is used at each construction site for project planning on the practical dimension, the WBS, cost account code and material code structures used on the conceptual dimension are also different from each other. On the other hand, there is standardization in certain areas, such as codes used in the legal accounting system.

As a result, the firm cannot properly use its IS and IT. No distinction has been made between an internal core IS towards the strategic objectives of the firm which are independent of the project, and the factors that affect each construction site, which serve the strategic objectives, and an external IS which serves the surrounding requirements and operational objectives shaped by the project factors.

The IS approach of the firm has shortcomings with regard to the human dimension. Since an IS design toward the strategic objectives is excluded, human qualities, which are an essential constituent of this system, have not been identified. No job descriptions have been made for the positions filled by these people. The human factor concerning the IS and IT, the roles of these people in the organizational structure (especially on the construction site) have not been defined. The need for job descriptions was met by the work group based on the information gathered as a result of the study.

The most striking point observed during the interviews was the fact that the staff members, including some mid-management staff, have confessed that they do not have sufficient information about the structure of the firm or the projects contracted. Insufficient information about the vision of the firm decreases chances that these staff members will contribute to the competitive advantage of the firm.

It was observed that even in the forms for gathering data at the construction sites there was no uniformity, which is the result of making an IS specifically for each construction site.

Through interviews conducted and from documents gathered, it was established that the information sent to the headquarters was lacking in the most necessary information, but contained much information that was not essential and some information that was too detailed, because the IS was misdesigned in terms of reporting purposes. Some information was directed to the headquarters as it came from the sites with no interpretation or sifting. Sometimes the headquarters showed no interest in such information, or had difficulty in making evaluation of this information, and thus made erroneous evaluations.

Experience gained through completed projects remained in the minds of the employees and on documents. Since the documents were not subject to a systematic processing, and the great majority of the personnel were not permanent employees, a corporate culture and memory could not be developed. However, organizational memory is one of the most important assets of a firm, and IT can be used as one of the most important tools to create an organizational memory. The magnitude and quality of organizational memory can be enhanced by IT.

Some omissions and errors in procedures, and incompleteness or superfluousness in the incoming and outgoing information, inconsistencies at detail level and lack of a system were found during the studies conducted by means of IS analysis tools.

Conclusions and Recommendations

The findings of the IS analysis study conducted for the said construction firm makes it possible to reach these general conclusions:

The construction sector conducts a manufacturing function based on the “project” approach. It does not involve the continuous and repetitive structure of industrial production. Each project has its own specific conditions. While it is possible to create universal models for firms in the same production field in the industrial sector, due to numerous factors, such as the rapid change of the organizational structures, the variety in the activity areas and locations, and the demands of the customers, such a universal model, even at the firm level, cannot be designed in the construction industry.

There are even more factors at the project level, and the project delivery systems and the roles of the customers and other participants make it impossible to achieve a uniformity in many areas as well as in terms of IS at the project level.

In these circumstances, at the construction sites where the production commences within a very

short time and is conducted rapidly, the main objective is to meet the information requirement of the "local" parties, and the IS and IT are designed as specific to the project and the site with an "opportunistic" approach.

Theoretically, there may be two extreme situations from the contractor's perspective. All factors being uniform for all projects is an extreme situation. Having all different factors is another extreme situation that is closer to the reality. In these circumstances, contracting firms must first define the information they need from the strategic point of view. This is a must to form the structure of the system for that part of the information that they have obtained from the sites.

The "internal" IS which will produce, record and organize the information at the construction site (project) level for the support of the firm and the business in terms of strategic advantage and the "external" IS which will assist the performance of the functions related to the project at the operational level must be thought as different from each other, but integrated at the project level; the internal IS must be standardized and set up uniformly as a core system at each construction site and be connected to the headquarters.

The personnel to operate this system must be trained in accordance with the structure and mentality of the IS, and a corporate culture must be developed in this respect. This approach, which may be difficult to adopt in the construction industry where the employees are dispersed after the completion of each project, must be adopted at least for the core staff.

After completing the system analysis studies for the stated firm the findings are used for different purposes. One of the main steps suggested by the research team was the development of a computerized model that aims to expose the structure of relationships among the management-related functions in information systems for construction companies. This study has been carried out and completed by Kanoglu in a research project already stated, supported by the Scientific and Technical Research Council of Turkey (TUBITAK). The models **ASAP - A**utomation **S**ystem for **A**rchitectural **P**ractices, ASCC – **A**utomation **S**ystem for **C**onstruction **C**ompanies, and integrated model of these two models, **MITOS - M**ulti-phase **I**ntegrated Au**to**mation **S**ystem for A/E/C Firms) are the outputs of this project. All these models were based on the experiences gained by the study stated in this paper.

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