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Impacts of Web-Based Collaboration in Managerial Control and Work Practices: The Case of Introducing a Web-Based Collaboration Platform in a Construction Consortium

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ABSTRACT

The focus of this paper is on the implementation of collaboration technologies in the context of the construction industry. Our empirical setting involves the introduction of a web-based collaboration platform for improving project management and control in a construction consortium, constituted of geographically dispersed organisations. The main objectives of this study have been to investigate how collaborative technology mediates in complex processes (task allocation, time scheduling, coordination of the building process) and how it contributes to the co-ordination among the multiple organizations (prime contractor, contractors and their various sub-contractors) participating in the consortium.

INTRODUCTION

The construction industry in general is highly fragmented compared to other manufacturing industries. Danwood et al. (2002) mentions that this fragmentation is due to the uniqueness of its production processes and the products themselves. In construction projects, a variety of organizations temporarily join together to create a 'temporary multiorganization' (TMO) (Cherns and Bryant, 1984) to discuss and exchange information within the durations of the projects.

This research has been conducted in the Greek construction sector. Several reasons made the choice of Greece an extremely interesting ground for drawing conclusions of wider relevance to the domain. The Greek construction sector is experiencing a significant growth, mainly resulting from the Olympic Games of 2004. As a result, the sector is undergoing tremendous changes both in its structure and in the way that business is conducted. In this background a research trying to identify the role of IT becomes extremely interesting. The purpose of this study is to uncover the many challenges with regarding the implementation of web-based collaboration technologies, and the continuing work in developing effective work practices related to this particular type of technology, and delivering important managerial implications.

The Need for Adopting Collaboration Technologies in the Context of the Construction Industry

Although Information Technology (IT) is often emphasized as an important enabler for this organisational transformation, there is a propensity to overplay the role of IT in this restructuring, by offering the potential for collaboration across geographical and organisational boundaries (Baskerville and Smithson, 1995). Internet based systems provide the capabilities of sharing, diffusing and managing information across time and space. Such systems are mentioned in the literature as web-based collaboration platforms (Munkvold, 1999).

Construction is a multi-organisation process with heavy dependence on exchange of large complex data and information. Thus, an information lattice is created, where actors diffuse and exchange various categories of information. Rojas and Songer (1999) note that two-thirds of the construction problems were caused by inadequate coordination and inefficient means of communication of project information and data.

By using sophisticated IT applications (e.g., web-based technologies), co-ordination, collaboration and the accomplishment of the work itself may become independent of time and space and can be carried out by distributed groups (Wigand et al., 1997) and organisational settings. The notions of co-ordination and collaboration may imply increase complexity of tasks and processes. To this respect, organisations strive for solutions or mechanisms that will be able for organising the work by its nature, and such a mechanism is project management. Project management is expected to coordinate and integrate all activities needed to reach project goals (Meredith and Mantel, 1995). Alshawi et al. (2003), state that current project management practices are often isolated and concerned with managing problems related to individual stages of the projects. Specifically he locates project management problems in construction to the lack of adequate communication. Communication problems often result to additional expenditure due to reworking. The Built Environment and Transport Panel (1998) states that 30% of construction rework is attributable to process-related problems.

Research Objectives

The proposed research seeks to identify impacts in management and work arrangements in a network organizational setting created specifically by the introduction of a new information system in order to support collaboration and information resource sharing for improving project management practices. In general, groupware or collaborative technologies are expected to support groupwork activities, such as planning, coordination, decision making, and so on (Ngwenyama and Lyytinen, 1997). Concomitantly, other authors claim that there is a great lack of understanding the complex social activity that is constitutive of groupwork (Kling, 1991; Grudin 1991). In this paper we present an illustrative case study to illustrate the social intricacies and afflictions by articulating the complexity of implementing a specific groupwork technology. Grudin (1991, 1994) also suggests that the failure to address the social dimension of groupware implementation leads to user rejection of otherwise designed applications.

The specific objectives of this study are to investigate the:

- Impact of collaboration platforms adoption on managerial control.
- Impact of collaboration platforms adoption on network participants' work practices.

METHODOLOGY

Since emphasis was on understanding the process of the virtual team adapting the technology over 8 month life span, a descriptive case study was used (Walsham, 1993). Case study is a well-accepted approach to study the complex phenomena of technology implementation in an organizational setting (Orlikowski and Baroudi, 1991; Yin, 1994). As a primary source of data we used more than 25 interviews with the IT consultant who was responsible for the system's implementation and documentary materials, which is a widely accepted effort for data collection (Myers, 1997). We also interviewed the IT developer at several junctures during the implementation process to determine his original intentions regarding the use of the technology and to understand how the technology had been finally used. In addition to the interviews, we also examined the entries created by the consortium in the system to examine how it was actually being used. To this end, we became observers in order to understand how the team's use of the system evolved. We were also present during some audio and video conferences, watching various entries to the system.

Case Description

The construction consortium examined in the Greek construction industry is a temporary project driven by organizational network. Dimer, a Greek construction company, is the prime contractor of the construction consortium. Dimer adopted a web-based collaboration platform in order to improve co-ordination of project work (in this case the network's mission concerns the construction of a new hospital wing), monitoring and reporting the progress of the construction project. The consortium consists of five geographically dispersed partners bound by contractual agreements (Technical and Financial Annexes).

The system is called "I-construct" and comprises a management platform available through the Internet, addressing the specific needs of the construction industry based on Microsoft Technologies. It offers users the strength to have access instantly via Internet, without necessary having their own PC with them. It is an integrated electronic management information system for successful project management and administration while it also supports daily project operations and administration by providing the following functions:

- **Project Management and control.** Includes the online updating of the project plan, construction site diary and communication log. (create/update project plan, timesheets)
- **Collaboration and communication.** It enables the on line collaboration between teams of the project, either within or outside a corporation. (online meetings, video conferencing, chatting, redlining)
- **Document management.** Document workflow in real time for Requests For Information (RFIs) and task assignments to project members (permissions, authoring, logs, redlining)
- **Information workflow.** Interfacing with legacy applications such as Project Scheduling, ERPs, etc. (online forms, control of workflow)

Roles and Responsibilities

The following actors have been appointed from the prime contractor to use the system:

1. CEO of the prime contractor
2. Project manager
3. Procurement manager
4. Construction work flow supervisor
5. Construction site manager

The CEO of the prime contractor had the overall project accountability with reference to project clients (in this case the Ministry of Health). To this end, he bought the system to monitor the overall construction process of the project. The project manager was located in both the construction site and the head offices of the prime contractor. He was responsible for managing and controlling this particular project and also reporting to the prime contractor all the relevant information about the project's progress and completed tasks according to time schedule. The procurement manager was located in the head offices of the prime contractor and was responsible for supplying the construction site manager with materials and equipment. He was assigned the task of reviewing the orders sent from the construction site manager and was authorized from the project manager to proceed in the delivery of the requested materials and equipment. The project manager and the prime contractor had the opportunity to monitor the whole process. The construction workflow supervisor was responsible for informing and consulting the construction site manager about revisions on technical details of project activities by submitting field orders. The construction site manager was responsible for constructing the side wing of the hospital according to the drawings and studies produced in the design phase. He was also obligated to follow the instructions given from the project manager and the workflow supervisor, and responsible for reporting the completed tasks back to the project manager. The following figure illustrates the interactions and the information flow that took place in the hospital project between the involved actors.

PRELIMINARY FINDINGS

This section presents the preliminary research findings extracted from the numerous interviews conducted with the IT consultant in order to understand and determine system's original intentions regarding its use and investigate how it had been finally used.

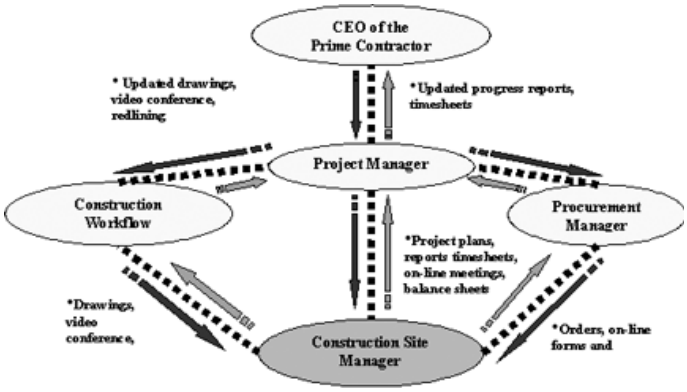
Electronic Communication of Information vs. Established Communication Procedures

Prior to the introduction of the system, information exchange was rather problematic because the interested parties had to save drawings in CDs and then courier them to the interested parties and so on. Through systems' functionalities their expectations were shifted because they were aiming at storing specific plans and drawings to specific folders, which would have been accessible through the web. A second goal for achievement was to reduce money spent on disputes and time traveling. Time and money spent was expected to be reduced because the system premised to create a full audit trail containing all the meeting minutes, actions, comments requests, approvals and notifications generated during project's lifespan. The important benefit for the project manager and the prime contractor was to be aware instantly of who has published what, when it was seen and by whom. However, the reality proved to be different.

First we note that the type of information exchanged had a high degree of abstraction. Furthermore, forms like "requests for information" (RFIs) that the construction site manager had to fill, did not have any standardized form able to refer to certain tasks or specific processes involved. In the process of revising the implementation study/plans, the construction workflow supervisor was responsible for monitoring the tasks and the processes of the construction project process in correspondence to the feasibility, architectural, electric and mechanical studies. The project manager illustrates bellow the complexity of the amendment process in the construction project:

"Our purpose for introducing the system to the consortium was to reduce paperwork and bureaucracy. However, established procedures in the construction are very difficult to overcome For example, when a drawing had to be amended, the revised version of the drawing as well as the instructions following it, needed to be in hard copy form in order to be confirmed with the architect's signature. The receipt of the drawing had also to be acknowledged to both the project manager and the prime contractor in writing. Therefore, sending these documents electronically failed to complete these endorsement procedures. The mixing of hard and electronic copies in the participant organisations made it extremely difficult to process the right information whenever it was necessary."

Figure 1. Information Flow and Interactions within the Consortium



Mistakes and misinterpretation of information has occurred since drawings and documents had not been up-to-date and instantly available. Team members confronted daily the risk on acting on information that is out-of date, or incomplete. This resulted in the augmentation of site visits and travelling time to meetings to resolve misunderstandings.

Introducing New Work Practices

The introduction of the system was accompanied by changes in the nature of both specialists' and managers' work. "I-construct" allowed specialists to electronically document every step they took in the process of resolving a particular incident. For example, the construction site manager had to fill in forms, send orders and keep a project diary electronically, and distribute RFI's instead of using former means of communication, such as the telephone or fax. The focus of his work shifted from primarily construction and solving problems in the construction site to both actual construction and documenting work in progress. The lack of standardized information trails, tasks and procedures in conjunction with the low level of understanding that a person might have when introduced to a new mean of communication, resulted in growing hesitation and uncertainty to the construction site manager on system's use and competences. We also found that the real problem was located on the training courses of the construction site manager which proved to be inefficient and resulted most of the difficulties met regarding the use of the system. The IT consultant states:

"…the construction site manager participated to the training courses occurred to all users simultaneously and not individually due to time restrictions. There was a great hurry for starting the construction work and the training courses were being based on an earlier version of the platform than the one which was finally released. However, we noted to the prime contractor that the construction site manager had a low IT literacy level, and that he would need some extra courses to attend in order to be ready with the release of the system. But the prime contractor claimed that time was mot enough and that the construction site manager has been doing this job for almost two decades and he knows his work better than everybody else…"

The ordering, purchasing and invoicing practices had a lot of shortcomings in terms of delays in supplies being received and led to less collaboration of the construction site manager and the procurement department. For example, many delays occurred from the integration of the existing material procurement system with the new platform, which did not integrate well with project plans and schedules. This resulted in the loss of the stock control of the materials and the inability to make accurate predictions of the resource requirements for the project. Finally, poor communication and collaboration among the procurement department and the construction site manager was the outcome of the overall lack of the system's integration to cater this need.

IMPACTS AND IMPLICATIONS OF COLLABORATION PLATFORMS ADOPTION

This section discusses the further implications extracted from the preliminary findings to address the research objectives of the paper.

Impacts on Managerial Control

The collected information consisted of periodic progress reports, specification changes and alike. However, we were unable to determine precisely which of the available data should be collected and allocated to specific actors. Due to the ineffective organization of project documents, users tended to receive irrelevant information. Furthermore, the degree of the detail that the exchanged reports entailed, both in the reports themselves and in the input being solicited from the actors, was very high and unstructured. This resulted in a negative propensity on system's use and performance from some actors (e.g. construction site manager, procurement manager). Moreover, this situation made almost impossible for the project manager to instantly assess the information needed to monitor specific tasks. Each of the participant organizations had its own information standards of forms and documents that are being exchanged. Basically, there was a high inadequacy of the *de facto* standards, related to the construction project processes. This inadequacy of formal standards of construction processes created further inconsistencies and ambiguity in information produced and exchanged. This delivered an extra ambiguity on how actors perceived the information and data received, and sequentially how users perceived the system and its use.

We also observed that organizations were keeping two different levels of information,(inter-organisational and network level) and they would have to adjust and assimilate their internal processes and sub-processes with system processes with tremendous implications in an inter-organisational level, in the sense that this change would directly affect internal structures and the people in them. Project management demands a highly structured information environment in order to retrieve the information needed for critical and objective decisions to be made. The unstructured information environment led to false decisions due to an incomplete representation of the situations. Scanlin (1998) points out, that communication consumes about 75-90% of a project manager's time and information therefore needs to be current and available on demand. This allows us to conclude that communicating information by electronic means affected seriously the effectiveness of the project control by the project manager.

Impacts on Work Practices

Actors' familiarity (Ciborra, 2000) with the use of such technologies was very low, while actors' IT literacy level was diverse. Furthermore, there was no customized training according to specific roles and particular business processes. The construction site manager at the end considered the system as a tool for spying on his every day work and claimed that it added only extra bureaucracy and time wastage. The system also resulted in a possible fear of exposure among the users. The prime contractor claimed that the technology destabilized current strategy and created imbalances, by failing to accomplish current needs. The various problems with interoperability, instability and performance of the technologies results in users developing mistrust in the new technology and thus, preferring to use substitute media, e.g., fax instead of e-mail. In summary, the introduction of this new IT application to support the construction consortium had multiple implications in terms of management and work as a result of the emerging socio-technical dynamics.

However, the definition of appropriate work tasks during the construction phase can be a laborious and tedious process. This is due to the unique nature of construction projects in general, which involve too many individual and different work tasks and make their definition an expensive and time consuming process. Fortunately, a real optimistic

fact is that many tasks in the construction may be repeated and used as general models for new projects. The problem though stems from the fact that this can happen within the same organisation since the industry lacks of standard processes and procedures adopted from the whole industry. Nevertheless, it is somehow encouraging for construction organisations to use such systems to store and retrieve the activities associated with past projects in order to create an information repository for internal use.

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CONCLUSIONS

Managing information as opposed to above, in integrating construction and collaboration processes, does not dictate the efficient use of a collaboration platform. Whether a new technology is introduced to one or many organisations, significant changes are implied not only to the organisation using it, but also to their structure and core processes. This imposes major implications on the work conditions as far as the introduction of a new IT application influences roles, tasks, co-ordination activities and so on. In this respect, these systems (platforms) necessitate the formulation of new formal and informal work procedures (i.e., roles, tasks, co-ordination activities) that need to be embedded into existing 'compulsory' processes as well as in informal norms (Orlikowski, 1996; Ciborra, 2000).

However, as Alshawi et al. (2003) notes unlike many IT tools, web-based tools are very much concerned with the exchange of information across the project lifecycle and therefore, their successful implementation requires the same degree of readiness within the network of organisations. This makes the implementation process very complicated and difficult to the extent that it requires new approaches and views to be examined, rather than traditional ones. Further investigation is needed to shift the focus of adoption efforts from ensuring system utilisation to rethinking about work processes and negotiate a viable network strategy for accepting new processes. Finally, from an industry perspective the establishment of information and procedural standards is essential in order to contribute to the design and the adoption of such systems at an industrial level.

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