INFORMATION FLOW MODELS FOR LARGE SCALE PUBLIC PROJECTS

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Public organisations are renowned for their relatively conservative or legally restricted methods in handling documents and information flow. In this study Turkish State Hydraulic Works (DSI) is taken as the model project owner and the information flow between the contractors and DSI is studied. DSI is the owner of dam/hydropower developments in Turkey and therefore is at the centre of the project information flow. These projects are processed in regions located away from the urban centres and for that reason the communication between the site and the participant organisations is meticulously managed during the project life.
In this ongoing study, IT-based information systems and flow in such projects are analysed and discussed. New methodologies and systems have appeared with the recent expansion of e-commerce. Some of those are recommended, in a re-engineering approach, for the improvement of the information flow, data storage and the regulatory approval procedures.

Keywords: information system, information technology, information flow, re-engineering, public organisation

INTRODUCTION

The public organisation DSI - State Hydraulic Works is one of the largest State organisations in Turkey. It was established in 1953 and its mission is to provide benefit from the large surface and underground water resources of the country. In order to achieve its target, it is responsible to construct dams and other facilities for energy production, irrigation, water supply and flood prevention.

In most developed and developing countries water supply undertakings come under extensive government control exercised through legislation, regulations and inspection procedures enforced by a government department responsible for water. Water resource projects are generally very expensive.

Our study and suggestions are modelled on an actual DSI project, a Dam/Hepp project currently under construction in the Black Sea region of Turkey. Information flow of DSI and a consortium were examined.

DESCRIPTION OF THE PUBLIC ORGANISATION

Water structures may cause big catastrophes in case of a failure or may require very high repair costs in case of damages. For these reasons, DSI qualifies companies as partners, for planning, design and construction. DSI is responsible for providing its services all around the country, which is divided into geographical DSI regions. At each region a regional directorate is established, responsible for the projects within

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their region boundaries. The regional directorates, which report directly to the DSI General Manager, establish several branch directorates in their region and each branch directorate is, in turn, responsible for a particular area.

The General Directorate of DSI is located in Ankara and is divided into specialised divisions such as Division of Dams and Hydroelectric Power Plants (HEPPs), Division of Project and Construction, etc. Divisions are in turn divided into branch directorates, which are also specialised on different subjects. The primary authority is the general manager. The General Manager delegates authority to the division and region directorates such that both the division managers and region managers are authorised to perform the jobs on behalf of the General Manager. Each unit in the organisation has its own hierarchy in it. According to this hierarchy, when a job comes to a division, the division manager assigns that job to the relevant assistant manager and similarly the assistant manager assigns that job to the relevant engineer. The reverse hierarchy is followed for the approval of the processed job.

Many of the projects of DSI are performed in rural areas. DSI controls and monitors the work performed at the site. The DSI control team is the primary observer and the authority of DSI at the site. Most of the project documents must be examined and certified by these control engineers (DSI Organisation, 2000).

IMPLEMENTATION OF IT IN PUBLIC PROJECTS

Information technology introduces many innovations for business, to the extent that processes must be redesigned considering it. Information technology reduces many unnecessary activities, decreases the process time and decreases the cost of business activities.

Studies in the international construction industry have estimated that over 85% of the information within most companies is not on a computer system and that managers obtain two-thirds of this information from face to face or telephone conversations. This situation is however changing rapidly. IT is the enabler for optimisation of the information process, but improving the information flow requires changes to basic behaviours, attitudes and incentives that relate to information (Bett, 1999).

In this part of the study, an alternative information flow will be proposed for public projects. In order to apply the information system to state projects, some legislative changes must be made and the form of contracts. For example, according to Turkish Law electronic records cannot be legal evidences in court. However, in many sectors such as banking, solutions to this are found, and if the electronic communication is proven to be sufficiently secure, some of the communication in public projects can in fact be performed electronically. However, for application of such e-commerce technologies in the Turkish public sector, some significant modifications in pertinent clauses of the law should be realised.

Information Flow Process

Many activities are performed during the business processes. Some of these activities are value-added activities, but evidently others are non value-added activities. Value added activities contribute the performance of the job directly and cannot be eliminated without damaging the job. Many non value added activities can be eliminated or reduced without impairing the operation (Juran and.Godfrey, 1998).

By examining the information flow diagrams of the public and private organisations in our model study the value added activities and non-value added activities are selected.

The purpose of these activities, are questioned and some information flow procedures are developed (DSI Barajlar ve Hidroelektrik Santraller Dairesi Baskanligi, 2000).

In making significant process change, information technology is often an essential enabler without which the process could not be reengineered. It has the potential to reduce organisational complexity, eliminate unnecessary work, simplify and streamline communications and co-ordination and facilitate teamwork. Many reengineered processes make use of information systems in replacing model processes that originated before modern computer and telecommunication technology. In addition to the role of information systems in improving processes, they also are critically important in management. These include establishing effective communication processes such as electronic data interchange between the organisation, contractors, suppliers and third parties, and enabling effective internal communications among individuals and teams with e-mail, team-based groupware and other information system tools. Such a system reduces the delays and errors that might occur if design and construction process had to await other, complex, error-prone flows of information.

Information Flow Process within Public Organisation DSI

DSI, as the client, manages the project and controls everything in the site. For this reason the General Directorate established regional directorates and branch directorates to manage the projects in Turkey. Branch directorates and regional directorates collect information about the projects in their zones and transmit them to the general directorate. When the information flow process of DSI is examined, it can be seen that the project documents are generally received by branch offices, certified there, sent to regional directorate, certified there, sent to the general directorate, approved there, sent back to the regional directorate and from regional directorate it is sent back to the branch office. Information flow between the geographically dispersed regions causes time losses in the approval process of a document. Under such circumstances departments mail or, if a courier is available deliver the documents, which may take a couple of days sometimes.

In figure 1 the basic mechanism of the information flow within a department in DSI is shown (DSI Organisation, 2000). There are three major steps in the circulation of the document: administrative office, manager and engineer. The approval or certification procedure is related to the authority of the employees within DSI. If the control engineer were authorised to approve the documents, none of the documents would be sent to general directorate.

In the approval process of a document, activities performed by the administrative office are all non value-added activities. Such jobs do not require interpretation and qualified personnel. In fact a transaction processing system can easily substitute such a job. In figure 2, administrative activities will be performed by the system without any loss in time. The manager assigns the documents to the relevant personnel. In some cases a document is checked in two or three departments. In this case the control process is performed synchronously by those divisions. In this case, the engineers may check the document being unaware of the changes made by the other division. This is one of the main problems. In figure 3, assigning, and managerial activities will be performed in the computer system.

Process no	Division		Subdivision		
	Admin	Manager	Admin	Manager	Engineer
1	R.T				
2		AS			
3	R.T				
4			R.T.		
5				AS	
6			R.T		
7					EX.C
8			R.T		
9				C	
10			R.T		
11	R.T				
12		AP			
13	R.T				

R	Record
T	Transport
AS	Assign
EX	Examine
C	Certify
AP	Approve

Figure 1: Current information flow scheme in a DSI unit

Process no	Division		Subdivision	
	Admin	Manager	Manager	Engineer
1	Load	AS		
2			AS	
3				EX
4			C	
5		AP		
R, T are performed by computer				

R	Record
T	Transport
AS	Assign
EX	Examine
C	Certify
AP	Approve

Figure 2: Optimised Information Flow-1

Process no	DIVISION		Subdivision	
	Admin	Manager	Manager	Engineer
1	Load	I	I	EX
2			C	
3		AP		
R, T, AS are performed by computer				

I	Inform
R	Record
T	Transport
AS	Assign
EX	Examine
C	Certify
AP	Approve

Figure 3: Optimised Information Flow-2

Information Flow in the Contractor Companies

The private sector adopts itself to innovations faster than the public organisations. A recent Danish survey of firms revealed that a majority would not be able to run business at all if their PCs and network be removed. In the model study, for the transfer of information and documents, consortium members used e-mail, or delivery on CD-ROM. For solving conflicts meetings were set up and the minutes of meeting were distributed to the consortium companies, usually by using information systems.

What is missing for integrating the computer systems fully into the information flow is the authentication problem and data integrity. Data security must be maintained, so if the data is not protected during transmittal, it may be subject to attacks. Equally important, in the digital media there is no physical signature on the documents and the companies of the model project did not use any online authentication techniques. In case of a dispute the only records are e-mail messages, but since no authentication techniques are used, none of the claims have any support.

SUGGESTED INFORMATION FLOW MODELS FOR PUBLIC ORGANISATIONS

Suggested Model 1:
In the suggested information flow, a document soft copy will be loaded to the computer at the branch office. The system records the document according to its type, content, and other information about the document. The system gives an id number to the document and stores the document.

The backbone of the procedure is to establish a wide area network. Local area networks at regional directorates, branch directorates and general directorate are all linked to the main frame at general directorate. Once a document enters into the system, it is held in the folders on the main frame. For the security of the system a firewall can be used. Firewall controls the information traffic between the networks and protects the data in the network from intruders. A proxy server installed in the firewall will control the access of internal users to external networks and the access of external users to the internal network. This system will protect the system from unauthorised access.

The administrative office enters the soft copy from one of the terminals at the LAN in the branch office. The regional computer transfers the document to the folders, which are established according to the project name and the document type at the main frame. The document will be available at general directorate, regional directorate and branch directorate at the same time. When a document enters the system, the manager of the branch directorate will be informed about the document, and the system will assign the job to the control engineer. This procedure is shown in figure 3. If the destination of the document is not defined, the system will send the document to the manager and warn him about the document. A password protection will be used to enter a session. It is one of the most practical authentication techniques although it has many risks. If a good replay protection is applied, the password system will be sufficiently secure. In this protection a value is calculated using the user id, password and system time. The calculated value, the user ID and the time is sent to the main frame. The Mainframe makes the same calculation using the same inputs and finds a value. If the received value and the calculated value is the same, the identity of the user is verified and access is permitted. By this way an intruder cannot access the system although he has the password. In the system each employee must have an authorisation level. The authority levels will be defined in the system. This type of access control will increase the security and the system becomes closer to the traditional system.

In figure 4 an access matrix is defined for DSI. The system will be loaded with access matrix information and the personnel information, which defines the organisation chart in the system.

When the document is promoted to the upper level, the lower level user cannot make any changes on the document. During the approval, certification and checking process, the system will record who made which changes on the document and it will automatically write their initials on the document. After the document is approved, it cannot be modified anymore. If any changes are needed, the authority that approved the document must release his approval otherwise the system will not permit for any

	Employee				
Document level	Engineer	Chief Engineer	Branch Manager	Division Manager	General Manager
Engineer	Read, Modify	Read, Modify	Read, Modify	Read, Modify	Read, Modify
Branch Mgr.	Read	Read	Read, Modify	Read, Modify	Read, Modify
Division Mgr	Read	Read	Read	Read, Modify	Read, Modify
General Mgr.	Read	Read	Read	Read	Read, Modify
Archive	Read	Read	Read	Read	Read

Figure 4: Access Matrix

changes. After the document is approved, the system writes an approval number on the document and sends it to the branch directorate. A hard copy of the document is produced and approved on behalf of the Public organisation. The system stores the approved document for later use. Then the contractor takes the approved documents by giving a document, stating that the contractor has received the approved documents. In the retail document control software Lotus DominoDoc, for example, the control of approvals and revision is done using an access matrix similar to Figure 4, and a metaphor of the author 'checking out' a document of the system.

In the proposed system, all the administrative tasks, and transportation jobs, are performed by the computer eliminating the time loss in these procedures. The initial entrance of the document to the system forms an exception. The administrative office performs initial entrance of the document to the system, while most of the job assignments performed by the managers are performed by the system.

As the information is available for all units of the organisation, so the information flow can be improved one step further, it is possible for the engineers to work on the document synchronously. When a document enters the system, the job will be assigned to the relevant engineer at branch directorate, regional directorate and general directorate and their superiors will be informed by the system synchronously. Engineers at geographically disperse locations will work on the same document simultaneously. In case of any changes made by an engineer, the relevant engineers will be warned about the changes. The managers can be involved in the checking process simultaneously (figure 6).

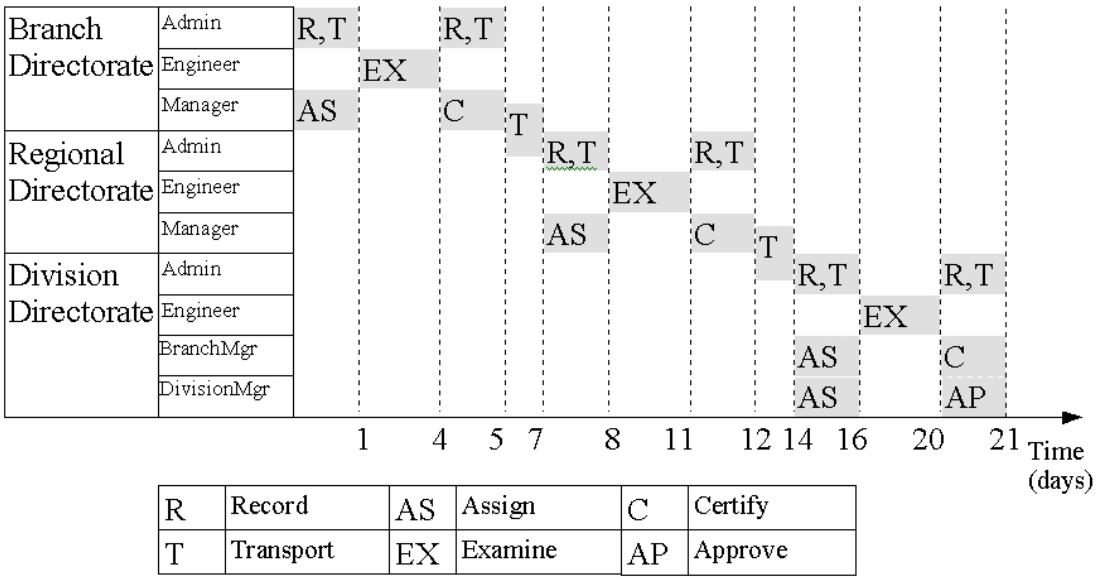

Figure 5: A sample schedule for approval of a detail design document

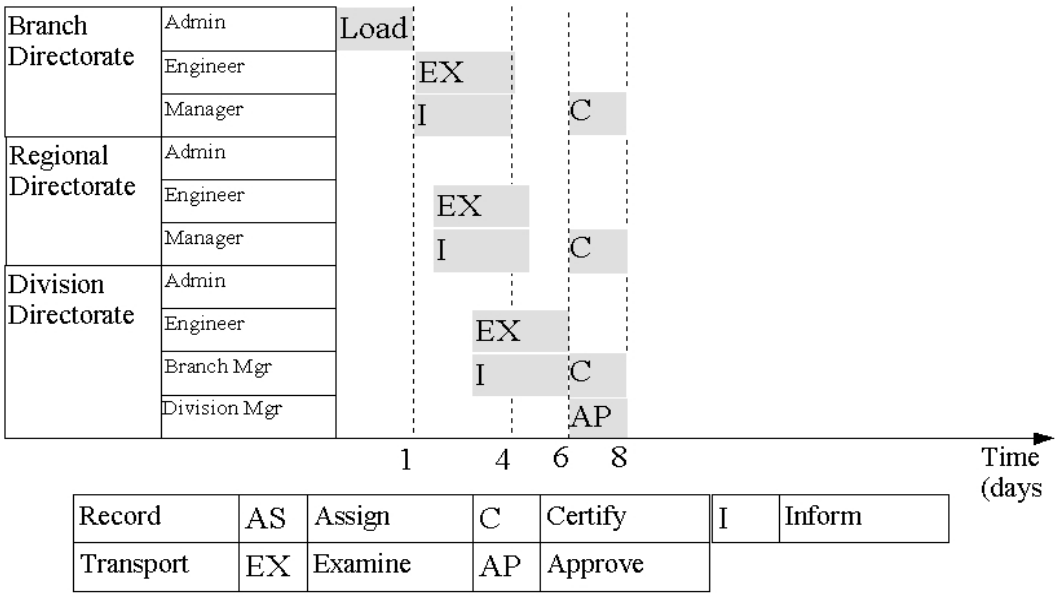

Figure 6: A sample schedule for optimised approval of a detail design document

Suggested Model 2:

This model is based on the soft copies and digital signature will be used for authentication of the originator and the integrity of the documents. Any change in the content of the document causes a change in the digital signature. Digital signature can be used for two purposes; Authentication, and Integrity Checking. In both cases the recipient does not know the enciphering key. As a minimum digital signatures must be kept secret and must be unique, but much literature is available on the subject (Varadharajan, *et al*, 1997; Beckett, 1997).

The digital signature system can be used for the information flow between the contractor and DSI. In this model, the contractor does not deliver the hard copy to DSI. DSI and the contractor will be given private and public keys. Private keys will be used to encipher the document and the public key will be used to decipher the document. The public key codes will be stated in the contract. In the contract some standards will be specified for the documents; such as a list of programs that can be used to create a document. Only the authorised personnel will be able to use the keys. The access to the private keys must be limited hence unauthorised parties' access must be strictly denied. In case of disputes, the contractor has the document, which has the digital signature of DSI, and DSI has the document, which has the digital signature of the contractor.

Suggested Information Flow for the Contractor Companies

Compared to public offices the private sector is less conservative and all its establishments apply information technology. But when their tools are examined, it is seen that authentication checks and integrity checks are not well performed. During the production of a document in the studied consortium, the Main Consultant (company BD) is responsible for the co-ordination and the production of the documents. Documents prepared by the other companies are checked by the Main Consultant (company BD) and distributed to the consortium through BD, and then other companies check the documents. In case of a revision, The Main Consultant is informed about them, and evaluates and revises the documents according to the requests. The revision of the document and production of the document are made asynchronously. Many revisions may be required. In order to improve the process,

number of revisions must be decreased and teamwork within the consortium must be established.

It is suggested that during the production of a project document, the local area network established at the Main Consultant allows access of the engineers from other companies. User ID's are defined for each engineer so that they can connect to company DD from any location with access to the relevant files. The engineers are given passwords and replay password protection is used. This way an unauthorised party can not access to the system. By connecting to the system, the other companies will be able to follow the progresses at the documents. If a change is made on the document, authorities in other companies are warned by the system. Documents produced by a team, composed of engineers from all companies, may reduce the revisions. Documents must be checked by the consortium companies; by using digital signatures. The Main Consultant distributes the document for final revision, enciphering the document with his private key. Recipient companies check the received document with the public key of the Main Consultant. The document is checked and enciphered, and sent back to the Main Consultant. If there are no changes, the Main Consultant sends the document for approval by enciphering the document with his private key. The preparation of the detail design document and the revisions made takes approximately 70 days. By the suggested information flow, the process time decreases to an estimated 40 days.

	BD Design Team	BD Elect. Coord	BD Mech. Coord.	BD Design Manager	BD Project Manager	Company E	Company M	Company H	Company SC	Company C	DSİ	Time Consumption
Preparation	●											20 days
Revision 1		●	●	●								5 days
Revision 2	●											3 days
Revision 3		●	●	●								4 days
Revision 4						●	●	●	●	●		5 days
Revision 5	●											3 days
Revision 6		●	●	●								5 days
Revision 8						●	●	●	●	●		3 days
Revision 9	●											1 day
Revision 10					●						●	20 days
Revision 11	●											1 day
Ready for Construction												70 days

Figure 7: Current process for the preparation of a guideline document

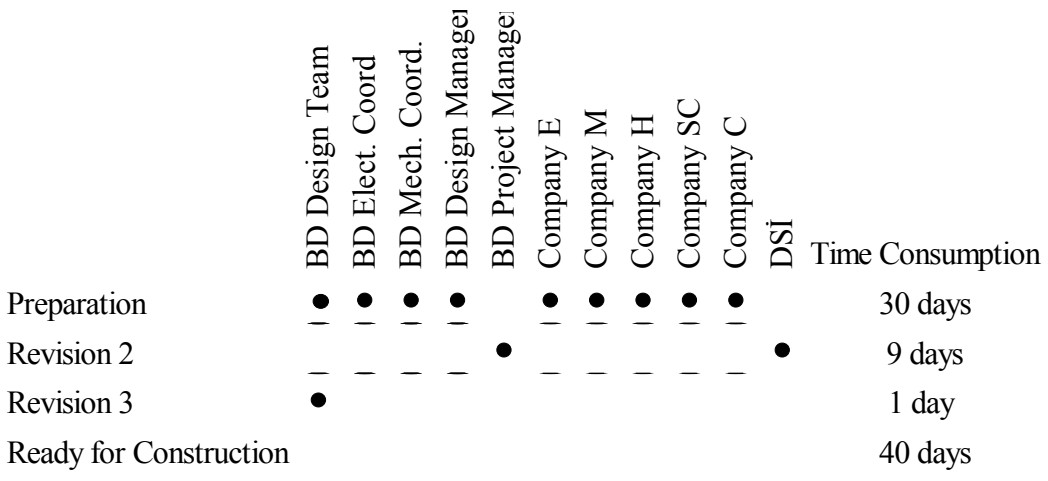

Figure 8: Proposed process for the preparation of a guideline document

CONCLUSIONS

Current information technology is the enabler for reinvention in most business processes. It allows organisations to rethink in fundamental ways, how to work and how to serve public and customers. The new technologies bring new possibilities, not just automating the old processes.

For the public organisation in this study it was suggested that considerable timesavings could be obtained in the information flow, in particular by streamlining the regulatory approval procedures. However, especially in public organisations, an increase the use of IT requires reengineering the whole business process. As a first step obsolete regulations should be cut and regulatory reporting should be reduced. Better compliance occurs when people understand what is expected from them. Top private companies are already using new technologies, and developing related strategies. Public organisations' goal should be streamlined and effective organisations by creating a more businesslike organisation. In order to achieve and sustain improvement in Information flow, organisational structures, systems, relationships, and all parts of the organisational culture may change greatly. The need for improvement is for the reduction of error rates, better quality control, and project time and cost otherwise shifted to the public budgets.

Little work has been done to quantify the extent and cost of errors and time losses in the information flow process. The cost of slow cycle time, ineffective and unnecessary administrative processes in useful and valuable systems may be quite large. Ineffective systems waste not only the administrative and support personnel who administer and execute them but also the time and energy of those who collect the data demanded, wait for the approvals, and so on. Administrative and support processes inconsistent with the rest of the organisation can generate significant drag on many activities; processes aligned with other organisational units and processes, however, can enable optimal performance. Many of the traditional, obsolete activities in an information flow process add little value to the organisation or its partners. Instead, by using IT, the organisation may devote its resources to activities seen to be truly value adding. Traditional methods should be replaced with improved methods using new technologies for an efficient, streamlined business process.

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