

TR3033J

# **STELLINGEN**

behorende bij het proefschrift

## **Designing electronic document infrastructures**

Jaap J.M. Uijlenbroek

21 november 1997

## I

In de discussie over de definitie van het begrip 'document' dient de informatie-inhoud van het document centraal te staan, niet de drager of de uiterlijke verschijningsvorm.

## II

Zoals het gebruik van moderne betalingsmiddelen niet heeft geleid tot het verdwijnen van baar geld, zo zal het gebruik van elektronische informatie niet leiden tot het verdwijnen van papier als gegevensdrager.

## III

Als gevolg van de opkomst van elektronische media, wordt het archivistisch vakgebied gedwongen zich te richten op haar kernexpertise: het bepalen van de waarde van informatie.

## IV

Archieven zullen tot in lengte van dagen, als gevolg van technische ontwikkelingen, worden geconfronteerd met nieuwe formaten voor digitale informatie-opslag. Dit uitgangspunt dient centraal te staan bij het inrichten van digitale archieven.

## V

De complexiteit van de invoering van elektronisch documentbeheer in organisaties wordt onderschat vanwege de conceptuele eenvoud van documentbeheer.

## **VI**

De invoering van elektronisch documentbeheer in organisaties heeft tot gevolg dat de verschillen tussen het dynamisch en het semi-statisch archief verdwijnen.

## **VII**

De overstroming van de Maas in 1995 en 1996 laat zien dat het succes van het poldermodel geen garantie biedt voor droge voeten.

## **VIII**

Het besluitvormingsproces over de vorming van stadsprovincies toont niet aan dat de overheid niet in staat is zich te transformeren, maar dat Thorbecke een vooruitziende blik had.

## **IX**

De hoeveelheid kunstschaten van Italië in vergelijking tot Nederland laat zien dat één gouden eeuw in de loop der geschiedenis gering is. Het succes van de Nederlandse economie dient in dit perspectief beschouwd te worden.

## **X**

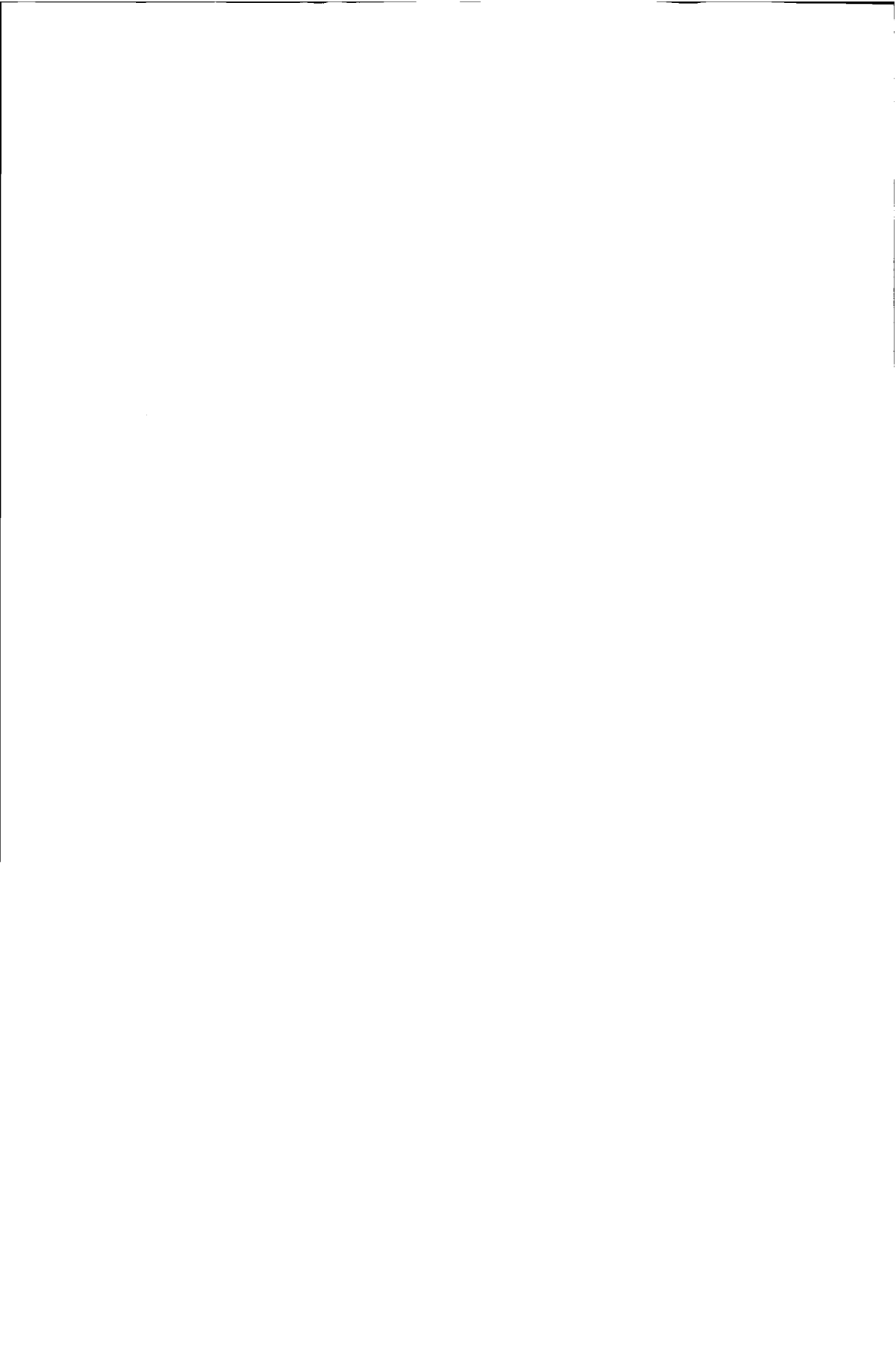
De toenemende druk op het groene hart doet vermoeden dat de HSL-tunnel het karakter heeft van een by-pass operatie: de levensduur van het hart wordt slechts tijdelijk verlengd.





TR3033

## **Designing electronic document infrastructures**



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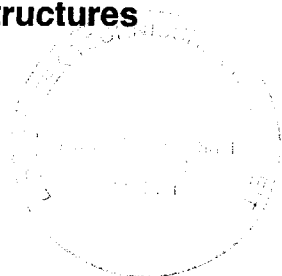
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ter verkrijging van de graad van doctor  
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**Jacobus Johannes Maria UIJLENBROEK**

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Prof.dr. H.G. Sol, Technische Universiteit Delft, promotor

Prof.dr.ir. J.L.G. Dietz, Technische Universiteit Delft

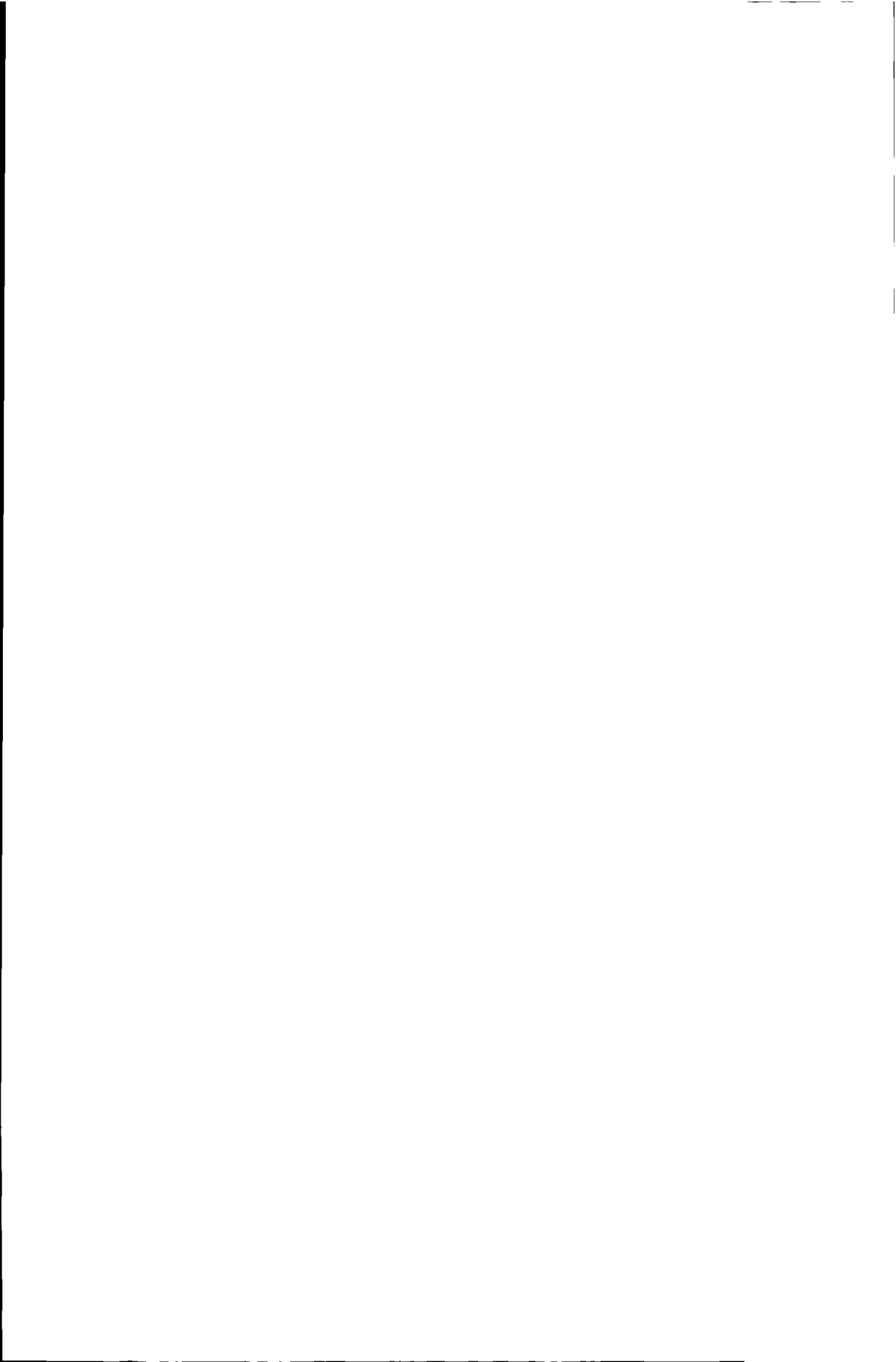
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Prof.dr. F.C.J. Ketelaar, Rijksuniversiteit Leiden

Prof. R.H. Sprague, University of Hawaii

Dr. K. van der Meer, Technisch Universiteit Delft



## Colophon

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J.J.M. Uijlenbroek

Terwindtplein 5

2807 RP Gouda

The Netherlands

Phone: (+31) 182.515217, Fax: (+31) 182.525367

Delft University of Technology

School of Systems Engineering, Policy Analysis and Management

P.O. Box 5015

2600 GA Delft

Phone: (+31) 15.278.2318, Fax: (+31) 15.278.3429

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*DESIGNING ELECTRONIC DOCUMENT MANAGEMENT*

## Preface

Nowadays, organizations heavily rely on information stored on computers. Large amounts of information are produced particularly by governmental agencies and information intensive organizations in the service industry. This is not limited to information structured in databases. In particular, the portion of documental information stored on computers is increasing rapidly. In general, information technology is regarded an important instrument to organizations in reaching their goals. The expansion of documental information stored on computers stresses the importance of document-based computers systems to organizations. In order to secure the contribution of document-based computer systems to the effectiveness of an organization, the latter should manage its electronic documents.

This thesis presents an approach to control electronic documents by assembling an electronic document infrastructure. The approach is based on three inductive cases, and applied in one case using action research. These cases show that document-related problems are closely connected to organizational problems. Consequently, the approach for designing electronic document infrastructures focuses on the relation between process control and document management. This research shows that an electronic document infrastructure contributes to the effectiveness and manageability of an organization. The contribution of an electronic document infrastructure to an organization's efficiency, however, is limited. This is explained by the fact that an electronic document infrastructure supports goal-based processes, to which the presence of complete and up-to-date documental information is essential.

Conducting research and writing a thesis is also a goal-based process which requires complete and up-to-date documental information. Moreover, the initial goal needs to be permanently focused on. I thank Henk Sol for focusing on the initial goal when I was wondering around in the world of document-based problems. He showed that an effective management style contains the following ingredients: being critical, being constructive, and being efficient. The latter in particular refers to our short, but effective talks. Furthermore, I thank Kees van der Meer for our inspiring discussions.

The Ministry of Housing, Spatial Planning and the Environment showed to be an organization with a variety of document-based problems. I thank Johan van Wamelen and Jan van Driel for opening doors in such a complex organization. During the case studies, many people employed by the ministry

have co-operated. In particular, I would like to mention Wouter Stapel of HIS, Ferry Carlier of the Investigation Service, and Ruud Schoonman and Freek Frederiks of the Department of Spatial Planning. They guided me through their organization and were always ready to assist me.

I owe many thanks to the Project Organization High Speed Line South (HSLs). HSLs showed confidence in the proposed theory for designing electronic document infrastructures, and was willing to implement the design in its day to day operations. In particular, I thank Dirk Zijp and Caroline Dijkerman of HSLs, René ten Hove of Betagraphics bv and the members of design team 4, whose contribution proved invaluable to the implementation of the electronic document infrastructure.

During the period of this research I worked as a consultant for ODRP facilitair bv, whom I thank for being a flexible employer. I particularly would like to thank Ad van Heijst, whose confidence I enjoyed, and Paul Gelderman for being a valuable colleague. During the finalization of this research project, I became a consultant of Het Expertise Centrum, which promises to be an inspiring environment for enriching my knowledge regarding electronic document management in a complex organizational setting.

Conducting research is one thing, writing down your research findings in English is a different matter. I thank Astrid Posthouwer for correcting the English concepts.

Conducting research and being a consultant consumes time, more time than available during regular working hours. Renske, I especially thank you for your empathy and patience.

Gouda, October 1997  
Jaap Uijlenbroek

# 1. Electronic Document Management

## 1.1 The need for electronic document management

### 1.1.1 The growth of electronic documents

Most organizations, especially information intensive organizations in the service industry and governmental agencies, produce large amounts of documents [Allerding 1992]. Lukanen [1988] shows that, in spite of the use of information technology, about 90% of all information only exists on paper. The portion of electronic information, however, is increasing rapidly. According to Weagemann [1992], in 1982 almost all information existed on paper, 2% of all information was stored on computers. In 1992, it was estimated that the portion of information stored on computers had increased to 14%. At this rate of development, Weagemann argues that in the year 2000 about 50% of all information will merely be stored on computers. The increase of computer-based information is supported by other research [Culnan 1992, Popkin 1993, Stroucken en Wingelaar 1994, Stiller 1994, Lannon 1994, Meier and Sprague 1996].

The technological developments enabling the support of document processing, explain the increase of information stored on computers [Sprague 1990 and 1995, Bikson 1993]. Examples of these technological developments are: digital image processing, large capacity storage, hypertext, multi-media documents, high bandwidth communication channels, electronic printing, electronic mail, and improved techniques for information and text retrieval. More recently, the use of internet and intranet stimulated the increase of electronic documents. These technologies enable the handling of documents and their 'media richness', i.e. the variety of communication media used in documents: not merely text, but tables, graphs, motion video, and sound. Traditionally, computerized databases focusing on highly structured information, have been largely unable to handle this richness.

Another explanation for the increase of information stored on computers is the importance of documents to organizational processes, management and control [Sprague 1995]. Already in 1978, Swanson and Culnan [1978] stressed the importance of document-based computer systems for planning and control. Documents include less structured information, which is of great importance to managerial decision making [Draft et.al. 1987, Van der Meer 1994 p.21].

Information technology in general is regarded an important instrument to contribute to an organization's strategic objectives [Rockart and Morton 1984, Sol 1984 and 1992, Porter 1985, Hirschheim e.a. 1988]. This strategic notion of information technology is even more of importance due to the increasing competitive pressure on organizations [Huber 1984, Rockart and Short 1989, Hammer and Champy 1993]. Document-based computer systems, a relatively new area of application, offer new opportunities to contribute to an organization's objectives.

To secure the document-based computer systems' contribution to the aims of an organization, the latter should manage their electronic documents [Butler 1989, Popkin 1993, Sprague 1995]. According to Butler [1989], electronic document management (EDM) links different technologies in order to handle different types of information, which are recorded, manipulated and managed electronically, while making use of a common access method. This does not mean that all information is kept in a common form. Instead, a standard method is used to access different types of information. In addition to providing access to documents, EDM should control the flow of information (e.g. documents). Notice that EDM is more than a software application to support document management: it includes technological, informational and procedural measures to deal with electronic documents.

The benefits of EDM are [Butler 1989, Green 1993, Rosman et.al. 1996]:

- unified accessibility of information;
- improved and concurrent accessibility of information;
- archiving consumes less time;
- improved control and management facilities;
- reduction of the space needed for archiving;
- improved security of information (both physically and logically);
- increase of organizational efficiency;
- integration of all relevant information sources for corporate purposes.

### **1.1.2 EDM: difficulties to overcome**

Applying document-based computer systems, by introducing electronic documents, generates a number of difficulties organizations have to overcome. This needs to be done in order to secure the document-based systems' contribution to the objectives of an organization. EDM deals with these difficulties, which relate to the management and control of electronic

documents, the tuning of document<sup>1</sup> services to organizations' critical business processes, and legal and technological issues.

Difficulties in the area of management and control of electronic documents are:

- *capturing critical information*

Evidence exists that information of potential record value is either not captured in organizational systems, or is captured but not identified as record material [Nara 1989, Bikson and Law 1991, Gilliland-Swetland et. al. 1992, Motiwalla 1993, Stroucken 1994]. Examples of missing critical information are e-mail messages containing important information which are exchanged without any kind of registration, and text files saved on a local hard disk which are deleted when additional disk space is required. This problem is even more complicated because documents, and the information they contain, have a meaning in a certain context [Van der Meer 1994]. To be able to appropriately interpret documents after a certain period, it is necessary to relate to both the organizational processes in which documents were used, and to the way they were manipulated by technological means. Hence, it is necessary to capture both the document and its context.

- *media richness*

Electronic documents include different communication media and require dedicated applications in order to present the information for human consumption. It is necessary to develop paradigms and practice for managing information in varied complex electronic forms [Langemo 1991]. For instance, how to deal with document manipulating applications, and how to make documents accessible with different communication media.

Defined in the traditional paper-based way, a record has the following characteristics: it is complete and independent, it has a stable visible format on which the data are recorded permanently, it has a clear life-cycle and a clear retention period [Bikson and Frinking 1993, p.86]. The concept of a record is traditionally used for hard-copies only. Due to the use of information technology [Jeng 1986, Saffady 1992], this concept is no longer applicable. For instance, a structured database containing information on which it is decided to grant somebody social security. Should this database and the application manipulating it be regarded as an electronic document with a high record value, or a printout of the data concerning the individual or the entire information system? And what about a text file which uses dynamic

---

<sup>1</sup>For convenience we consider documents and records in this chapter as synonyms. In chapter 2 these concepts are described in more detail.

links to spreadsheet files and other text files? Due to the inability of applying the traditional concept of a record, difficulties regarding capturing critical information and media richness arise.

The tuning of document services to an organization's critical business processes focuses on the way electronic document services can support organizational processes. Difficulties regarding the tuning of document services are:

- *information overload*

Electronic information is easily copied and dispersed. How can one be sure people only receive the information necessary to appropriately perform their task: nothing more and nothing less?

- *making information accessible*

How can large amounts of information easily be made accessible to information workers in a way that relates to their tasks? This problem is complicated because future information use is difficult to predict and large amounts of information may have a long period of use.

Paper documents have a high level of evidential value. The use of electronic documents instead of paper documents, generates a great impact on the evidential value. Difficulties related to the evidential value of electronic documents are:

- *authenticity and integrity of electronic documents*

Electronic information can easily be changed without any trace of evidence. It also allows deleting massive amounts of information with minimal effort. The integrity and authenticity of data and documents have to be ensured in order to fulfill requirements regarding accountability and public security of government, corporate and individual activities. Ensuring the authenticity and integrity of electronic documents is problematic [Weber 1990].

- *authorization*

How can the electronic document's construction by an authorized individual according to the appropriate procedures be ensured? Regarding paper documents, this problem is solved using watermarks, imprint, signatures and stamps. Counterparts in electronic documents are user identification, passwords and encryption. These are nevertheless not entirely satisfactory. Problems regarding authorization especially exist regarding the use of e-mail [Motiwalla 1993, Stroucken 1994].

- *paper documents and their electronic equivalent*

Substituting paper documents with electronic documents is not always possible, due to the difference between the evidential value of paper and electronic documents. Which technological, procedural and even juridical



measures are necessary to substitute paper documents with electronic documents?

Electronic documents only exist due to the technological progress supplied by the information technology industry. The development and use of new technologies and applications introduce new problems to EDM:

- *long term retention*

Despite problems with acidification, paper has proven to be a long term 'storage media'. Electronic documents are stored on a variety of magnetic and optical media. These media are not considered to be a permanent archival medium. Furthermore, the availability of hardware and software required to decode the electronic information is a problem in long term retention [Johnson and Kallaus 1982, Weber 1990]. Converting to paper is not always possible given the medium richness of electronic documents.

- *system dependency*

Electronic documents are created with dedicated systems. Both the document and the dedicated system need to be archived. Since these systems rapidly change and conversion is impossible due to information losses and problems regarding authenticity, archives will end up with a large variety of systems which will be outdated in the long term.

In order to ensure that the introduction of a document-based system is a valuable contribution to the objectives of an organization, the difficulties summarized above will have to be solved. Besides technological issues, these difficulties relate to legal, organizational, informational, and archival issues. In order to deal with these issues, EDM should integrate knowledge of disciplines acquainted with these issues. The following fields of study are familiar with these issues: archives management, information systems and organizational science. The field of archives management recognizes retention of documents, particularly paper documents, and legal issues regarding documents. The field of information systems contains knowledge of the design and use of IT in order to support organizational processes, whereas organizational science contains knowledge regarding organizational design.

## **1.2 Perspectives on electronic document management**

In this section, three perspectives on EDM are presented: the archival, the organizational and the technological perspective. Each of these perspectives defines documents in a different way, stressing a different view of the role of documents in organizations. Each perspective is based on a concept used in one of the disciplines mentioned earlier.

### 1.2.1 Archival perspective

Governmental, corporate and individual activities generate data and documents needed to be captured and stored because of the internal and external accountability of organizations and individuals regarding the performance of their work. The public accountability of governmental agencies stresses the importance. The Dutch Archive Law states that 'governmental agencies are obliged to ensure that records kept by them are in good condition, are properly arranged and accessible, and are thus maintained, and to arrange for the destruction of records which are eligible for destruction'<sup>2</sup> [Lieuwes 1996]. Records are defined as 'records in any form whatsoever received or created by an administrative authority which, by their nature, are assigned to be kept by that authority'<sup>3</sup> [Lieuwes 1996]. Consequently, any kind of governmental information, hard-copy or electronic, is considered to be a record. It is important to notice that a structured computer-based database also fits this definition. The archive law only applies to governmental agencies. Regarding corporate and individual activities, a number of archival requirements are formulated by law. The tax legislation, for example, obliges companies and individuals to preserve documents for a period of 10 years<sup>4</sup> [Böttcher 1993]. Furthermore, insurance legislation formulates a number of requirements regarding document management [Tulfer 1995], whereas the Civil Code requires companies to preserve their documents for 10 years.<sup>5</sup>

#### *Significance of documents*

The value of a document determines its destructibility. Archivists distinguish two types of values, the informational and the evidential value of documents. The informational value refers to the value of documents for organizational processes (e.g. the co-ordination between co-workers), public information (e.g. to supply the general public with information) and the continuation of the organization (e.g. organizational memory, management documents). The

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<sup>2</sup> Original in Dutch: 'De overheidsorganen zijn verplicht de onder hen berustende archiefbescheiden in goede, geordende en toegankelijke staat te brengen en te bewaren, alsmede zorg te dragen voor de vernietiging van de daarvoor in aanmerking komende archiefbescheiden' (art. 3 Archiefwet 1995).

<sup>3</sup> Original in Dutch: 'Onder archiefbescheiden wordt verstaan: ..... bescheiden, ongeacht hun vorm, door de overheidsorganen ontvangen of opgemaakt en naar hun aard bestemd daaronder te berusten' (art. 1 Archiefwet 1995).

<sup>4</sup> Original in Dutch: 'Hij die ingevolge de artikelen 47, 48 of 49 gehouden is desgevorderd boeken en andere bescheiden betreffende zijn bedrijf of zelfstandig uitgeoefend beroep ter inzage te verstrekken, is verplicht die gedurende tien jaren te bewaren.' (art. 54 Algemene wet inzake rijksbelastingen).

<sup>5</sup> Original in Dutch: 'Hij is verplicht de in de leden 1 en 2 bedoelde boeken, bescheiden en andere gegevensdragers gedurende tien jaren te bewaren.' (Burgerlijk Wetboek, boek 2 art. 10 sub 3).

informational value also refers to the value of documents and archives for reference and research purposes: the cultural and historical value. The evidential value refers to the importance of a document and archive in providing evidence about the origins, structures, functions, procedures, and significant transactions of both the individual and the organization [International Council on Archives 1984, Van der Meer 1994]. Official documents like agreements, written statements, contracts, summons, dispositions, etc. contain high evidential value.

From an archival perspective, the aim of EDM is to ensure the long-term availability of all relevant information needed for the reconstruction of an organizational process. This is merely possible if all relevant information is captured and preserved. This is a necessity for internal and external accountability. Capturing all relevant information, however, is not enough. Moreover, the context in which documents and archives are created is important for a well-founded interpretation of the information retained. In order to capture the context, two archival principles should be taken into account: 'provenance' and 'respect for original order' [Bearman 1993]. 'Provenance' refers to the principle that archives of a given record creator should not be exchanged with those of other record creators [ARMA 1985]. 'Respect for original order' refers to the principle that the historical order and arrangement of records should be preserved as originally generated [UN/ACCIS 1990].

#### *Archival approaches to EDM*

Bikson and Frinking [1993] describe two substantially different archival approaches to EDM, both focusing on information sharing and public access to governmental information. The first one is represented in the work of UN/ACCIS [1992]. This approach aims at locally captured, described and maintained information, accessible to other organizations. By using OSI (Open Systems Interconnection) standards, remote accessibility of the meta-data, and eventually the actual electronic documents, should become possible. A uniform information structure can be created, due to the standardization of records keeping goals which are based on the life cycle of electronic documents. Based on these uniform goals, functional requirements for new electronic technologies can be formulated. By applying these functions and using of OSI standards, one can be assured that information can be exchanged, stored, retrieved, and re-used in both hardware and software environments different from the record creator's environment. The other approach aims at the creation of a centralized meta-database, the Information Locator System (ILS), in order to achieve comprehensive documentation of all systems of electronic records [SARA

1988]. Disadvantages of the first approach are the immaturity of some OSI standards, and formulating uniform goals of record keeping in order to create a standardized information structure. Creating and maintaining a complete, accurate and up-to-date centralized inventory of agency records is the key difficulty in implementing the second approach.

The two approaches of EDM mentioned above, focus on the creation of an inter-organizational document structure. The approaches are based on standardized criteria for the selection of electronic documents for retention or destruction, without taking local differences into account. The PIVOT<sup>6</sup> approach of document management, both electronic and hard-copy, regards critical organizational processes as a starting point for the selection of documents [Biza 1991, PIVOT 1992, OCW 1994]. Contrary to the two approaches mentioned earlier, PIVOT opens up possibilities to take local differences into account when structuring information. In this approach, organizations analyze their organizational processes and determine the value of documents prior to the execution of these processes. Traditionally, as they enter the records department, documents are either selected for retention or destruction. By then, the organizational process which created the documents is ended. According to the PIVOT approach, documents which are destructible after the process is ended, do not enter the records department.

Documents hold a value which exceeds the immediate support of operations: the value to organizational memory and learning, accountability, future planning, and research. This value should also be taken into account when selecting a document for retention or destruction. Key question regarding the PIVOT strategy is how to ensure archival requirements which reach beyond the agencies' interest, such as cultural heritage and historical research. Ensuring these kinds of requirements prior to process execution, is quite difficult.

Process-oriented approaches to document management, like PIVOT, introduce notions from the organizational perspective (presented in the next section) to the archival perspective.

### **1.2.2 Organizational perspective**

Organizations are purposeful entities which attain certain goals [Ackoff and Emery 1972]. In attaining organizational goals, work has to be divided since

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<sup>6</sup> PIVOT is the abbreviation of 'Project Invoering Verkorting Overbrengingstermijn', meaning: Project to implement the reduction of the period of transfer of documents.

the resource of one man is limited. This division of work into smaller tasks gives rise to the adjustment of these tasks, requiring organizational co-ordination [Gulick and Urwick 1937]. Several ways of co-ordination exist: mutual adjustment, direct supervision and standardization [Mintzberg 1979]. Three ways of standardization are mentioned by Mintzberg: standardization of skills, work processes and output. Communication and information exchange form an important part of organizational co-ordination. Mutual adjustment thrives on informal communication. Direct supervision requires insight in work processes and actual status information regarding ongoing processes in order to allow instruction to be given to workers. The need for communication and information exchange is explained by Galbraith [1973], based on the uncertainty of the task: 'the larger the uncertainty of the task, the larger the amount of information that has to be processed between decision makers during its execution' (p.4). Consequently, task uncertainty leads to information exchange and, given the fact that documents hold information, to document exchange.

From an organizational point of view, electronic and hard-copy documents are means for communication and information exchange. Meier and Sprague [1996] discuss documents as being 'a mechanism for communication and a vehicle for business processes'. The events occurring during the execution of organizational processes are embodied in the information content of documents. The communication and information exchange that occurs during process execution, results in document exchange.

This perception refers to documents as raw material, processed to generate organizational output. The output, however, may also be a document [Van de Water and Mantelaers 1989]. The information content and the exchange of documents, being organizational output, are determined by the characteristics of the output. A rejection of a subsidy application, for example, needs to be motivated. The information content of the rejection is determined by the subsidy criteria. The rejection will be sent to the applicant. Prior to the sending, the rejection will be registered and a hard-copy or an electronic equivalent will be placed in a repository. Consequently, the information content of documents and the exchange closely relate to an organization's process and output.

This view on the relation between documents and processes is in line with communication-oriented analyses of organizational processes, such as the speech act theory [Austin 1962, Searle 1969 and 1979] and Demo [Dietz 1994]. These analyses regard documents, whatever type, as technological means used or required to perform a certain action. A documents is the

sediment of an organizational process, which explains why documents are a useful instrument in analyzing existing processes [Davenport 1993, p.89].

The information content of documents is of great importance to an organization. This importance is clearly expressed by Davenport [1993, p.301]:

'Information is itself a powerful process resource. Although we are just beginning to understand how to manage information in a process context, already it is clear that accurate, real-time information about process performance is a pre-requisite for effectiveness. Many processes have as their primary objective the creation of information.'

Managing the information content of documents in a process-context contributes to an organization's effectiveness. Hence, from an organizational point of view, the primary objective of EDM is to contribute to the effectiveness of an organization by supplying information when needed, and supplying status information regarding ongoing processes. In a large number of case studies, the introduction of document automation in organizations is described and the realized process improvement is reported [Butler 1989, Benjamin 1993, Popkin 1993, Davenport 1993, Bouwman 1995, Balmer 1995]. In the majority of these cases, the introduction of document automation was aimed at supporting new organizational forms. In these cases, EDM enabled organizational change. From the organizational perspective, the objective of EDM is therefore twofold: contributing to an organization's effectiveness and enabling organizational change. These objectives emphasize the combined design of organizational processes and supporting IT tools.

### **1.2.3 Technological perspective**

Documents contain a wide range of information types. Examples are text, objects, tables, video and sound in case of electronic documents, etc. Organizations receive documents by paper mail, fax, diskette, EDI or CD-Rom, etc. and store them on different media: paper files, hard disks, optical disks or microfiches. Documents, containing different kinds of information, have to be processed and archived throughout the organization. Currently, different media are handled in different manners, using dedicated technological means and organizational procedures. An example being the difference between the distribution throughout the organization and the archiving of paper and electronic mail.

From a technological perspective, EDM aims at integrating different technologies, enabling the user to deal with complex information types in an integrated way [Butler 1989, Popkin 1993]. A 'compound document' [Sprague 1995] holds different information types. Figure 1.1 shows an example of a compound document including a number of information types. Compound documents can also contain video clips, voice annotation, Cad/Cam-objects, graphs, structured database, etc. A compound document is not just a collection of information types. Linking different types of information into one compound document enriches the information content of the document. Compound documents require management on the level of the documents and the elements the documents consists of.

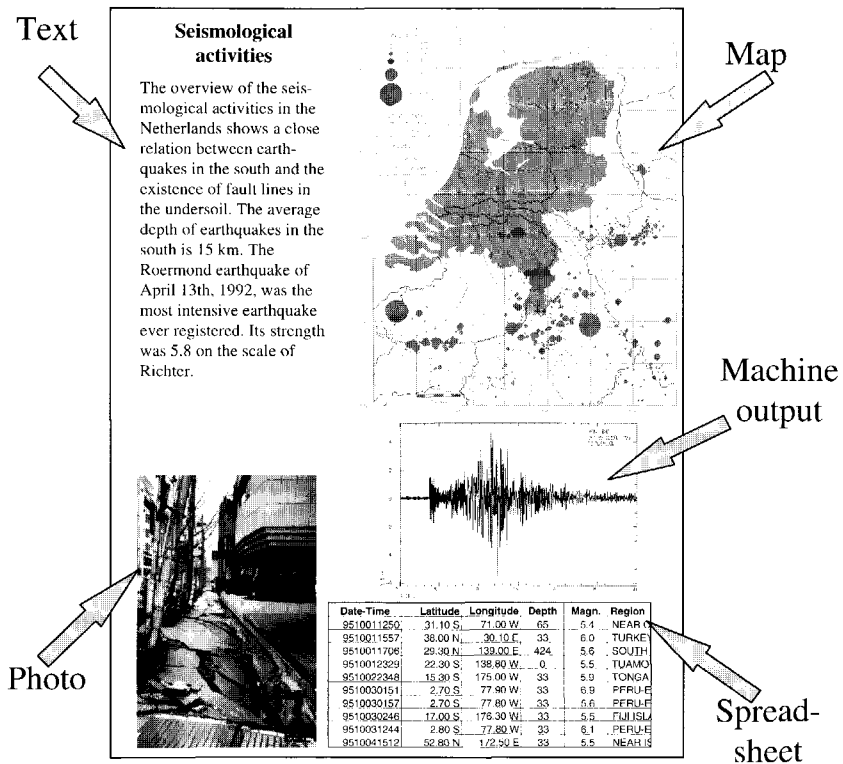


Figure 1.1 An example of a compound document [elements taken from [www.knmi.nl](http://www.knmi.nl)]

In order to support EDM, a wide range of tools is available on the market. Figure 1.2 [based on Emery 1993] shows an overview of EDM applications and related technologies. Some applications focus on the business process, some focus on the storage and retrieval of information and documents, and some focus on both. The choice of a certain software package should be

based on the characteristics of document and information handling, and the characteristics of the organizational process to be supported [Popkin 1994].

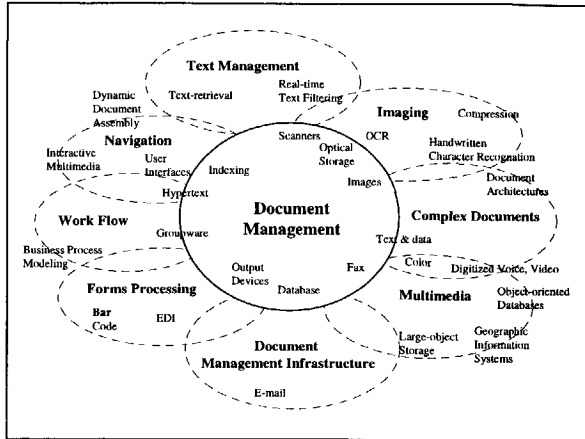


Figure 1.2 EDM: applications and technologies

This section is concluded by summarizing the objectives of EDM within each perspective, and the different kinds of values documents may possess.

Approach	Objectives	Significance of documents
Archival	<ul style="list-style-type: none"> <li>ensuring the long-term availability of all relevant information needed to reconstruct an organizational process</li> <li>ensuring capturing valuable (including evidential) information</li> </ul>	<ul style="list-style-type: none"> <li>informational value                             <ul style="list-style-type: none"> <li>value to organizational processes</li> <li>public value</li> <li>value to the continuation of organizations (organizational memory, management documents)</li> <li>cultural and historical value</li> </ul> </li> <li>evidential value                             <ul style="list-style-type: none"> <li>internal accountability</li> <li>external accountability</li> </ul> </li> </ul>
Organizational	<ul style="list-style-type: none"> <li>contributing to an organizations' effectiveness</li> <li>enabling organizational change</li> </ul>	<ul style="list-style-type: none"> <li>reducing uncertainty</li> <li>vehicle for business processes</li> <li>communication mechanism</li> </ul>
Technological	<ul style="list-style-type: none"> <li>integrating different technologies</li> </ul>	<ul style="list-style-type: none"> <li>increasing information richness</li> </ul>

Figure 1.3 Three approaches to EDM

### 1.3 A multidisciplinary approach to electronic document management

Since the formulation of a methodology for archives management in 1898 [Muller et. al. 1898], a new field of study came to development. The field of archives management developed independently of other disciplines, such as accountancy and information systems, which also pay attention to managing information. The use of automated tools has a great impact on the discipline



of archives management: on its theoretical foundations (e.g. what is a document?) and on how it is applied to real-life situations. Currently, document management and information systems management are approaching [Barry 1993, Bikson and Frinking 1993, Sprague 1995]. Both the PIVOT approach and the process-oriented approach to information systems development regard organizational processes as a starting point.

The relation between document management and automation is twofold. Traditionally, computers were only used to handle meta-information (e.g. description, location, etc.) in order to support the management of paper documents [Salton 1968]. This was a result of the fact that the information the documents contained was not available electronically. Since increasingly more documents are available electronically, a need exists to manage and control electronic documents. In order to fulfill this need, the implementation of archival principles in automated information systems which support organizational processes is required. Hence, it is frequently recommended that archives management functions should be considered while designing new information systems and applications [Bikson and Frinking 1993, p.65].

According to Leavitt [1956], an organization consists of four interdependent elements: task, technology, structure, and people. These elements are so closely related that changes in one element, either purposefully or not, will effect the others. Hence, each element may be an enabler for organizational change. The interdependency requires a simultaneous study [Davenport 1993, p.96]. From a technological point of view, information system design focuses on task and technology [Davis and Olson 1995]. Social-technical design approaches also focus on structure and people, studying each relation between these elements [Mumford and Weir 1979].

Document-based computer systems are part of the technology of an organization. A design of document-based systems, an application area of information systems, focuses on the design of task and technology. In this context 'task' should be broadly interpreted, containing both individual tasks and organizational processes. The object of this research is electronic documents, the data processed by document-based computer systems. A design for EDM should focus on electronic documents and its relations with the other elements: task, structure and people. Consequently, principles of organizational science should be incorporated into an EDM approach. Additionally, the EDM approach should incorporate principles of the field of information systems, since electronic documents merely exist as a result of the use of computerized information systems. The information content of documents is traditionally studied in the field of archives management.

Hence, this study will use three disciplines in constructing a multidisciplinary approach to EDM: organizational science, information systems and archives management.

Section 1.2 shows that the archival perspective to document management strongly focuses on documents as such, stressing the value of documents. The technological perspective emphasizes the IT tools available for document management. The organizational perspective presented in section 1.2.2 shows that the information content of documents is determined by the organizational process and output. Consequently, the organizational process is considered the starting point of the multidisciplinary EDM approach.

Bots and Sol [1988] use three perspectives in organizational design and improvement. Each of these perspectives focuses on different aspects of organizations.

- The *micro-perspective* focuses on the tasks performed by individuals and searches for possibilities to improve individual performance. From this perspective, individual performance is the main criterion for organizational design.
- The *meso-perspective* focuses on the organizational processes, emphasizing the co-ordination between individuals working together on a certain organizational process in order to realize organizational goals. Performance criteria relate to the entire process.
- The *macro-perspective* focuses on the environment of organizations and their relation to other organizations. From this perspective, the organizational chain is a dominant concept in analyzing interorganizational co-operation. Performance criteria focus on interorganizational efficiency and effectiveness.

Sol [1988 p.11] states that the dominant questions for each perspective, which should be addressed simultaneously, are:

micro: how can tasks at the workstation be supported effectively?

meso: how can flexible architectures characterized by effective process tuning be realized within organizations?

macro: how can co-operation between and above organizations be achieved with the result that all those involved profit permanently?.

Regarding EDM these questions are also valid. Dealing with different information types in an integrated way is especially important to the micro-perspective: not only the workstation should be able to deal with rich information, also the task should be designed in order to use rich information appropriately. How can one ensure obtaining all valuable documents

regarding an organizational process? How can one ensure dispersion of documents needed during the execution of a process at the right time and place? These issues are examples of the meso-perspective. Problems with long term retention, focused on the cultural and historical value of documents, are examples of the macro-perspective.

Archival approaches to EDM described in section 1.2.1 can be structured according to the perspectives on organizational design and improvement. The PIVOT approach focuses on the meso-perspective whereas the UN/ACCIS approach emphasizes the macro-perspective.

#### **1.4 Delineation of the research area**

The object of this research is electronic documents. Section 1.1.2 describes difficulties which arise due to the use of electronic documents. This thesis deals with these difficulties. Not all difficulties, however, are dealt with. No specific attention will be paid to long term retention of information and difficulties regarding standardization and system dependency. The other difficulties mentioned will be dealt with, focusing on active information. Archivists distinguish between active and passive documents. Active documents contain a high level of use and should be relatively easy to (re)use. Passive documents contain a low level of use. With a focus on active documents, this thesis will concentrate on the following problems with electronic documents:

- capturing critical information;
- media richness;
- improving the accessibility of information;
- authenticity and integrity of electronic documents.

It is of great importance to solve these problems in order to allow electronic documents to contribute to an organizations' effectiveness.

Since the focus of this thesis is *electronic* document management, the attention is fixed on the use of information technology in order to support the management and control of electronic documents. Hence, attention will be paid to the way existing applications and technologies can be used in order to support EDM. In order to contribute to organizations' objectives, special attention will be given to the design and implementation of EDM-tools.



## 2. Electronic documents in organizations

### 2.1 Electronic documents defined

Chapter 1 presents a number of document related problems, without using a clear definition of documents. In this section, a working definition is constructed, using notions of documents existing in contemporary literature.

#### 2.1.1 Concept of documents

Sprague and McNurlin [1993, p.487] use two definitions of documents, one being narrow and the second being broad. The narrow definition is limited to 'paper documents or their electronic equivalent'. Technologies used to handle documents in this meaning are micrographics, computer output microfilm (COM) and digital image processing. Paper documents are the starting point for the application of these technologies. The broad definition focuses on electronic documents, holding a 'variety of symbols and media representing the ideas and concepts of the document'. An electronic document may contain graphic symbols, photographs, other images, voices, and video clips. The example of a compound document shown in section 1.2.3, is included in the broad definition of documents. Sprague and McNurlin propose the term 'infobundle' for compound documents because these are 'richer' than traditional documents. In contrast with the narrow definition, the broad definition introduces the use of different media (e.g. graphics, voices, video).

Van der Meer [1994, p.13] defines a document as 'an object which has the purpose, or to which the purpose is given, to serve the perusal of the information it contains'<sup>7</sup>. This definition does not distinguish the technology needed in order to inspect the document. Any item containing data is regarded a document: a letter or a book, a floppy, a chipcart, and even a traffic sign. Van der Meer uses the word data, thereby stressing the difference between data and information. Documents contain any kind of data, only when read by somebody it is called information. Van der Meer's definition aligns with the definition of Levien [1989]: 'a document can be described as recorded information structured for human consumption'. Similar definitions can be found in [Jeng 1986 and Saddafy 1992].

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<sup>7</sup> The original definition in Dutch: 'Een document is elk object waarvan de bedoeling is of waaraan de bedoeling wordt toegekend, te dienen tot kennisname van de gegevens waarvan het de drager is'.

The definitions of Levien, Sprague and McNurlin, and Van der Meer, emphasize the document being an object, either physically or electronically. Michalski [1991] focuses on the features of documents and their functions in organizations. According to Michalski 'a document is a snapshot of some information set that can:

- incorporate many complex information types;
- exist in multiple places across a network;
- depend on other documents for information;
- change on the fly (as subordinate documents are updated);
- have an intricate structure, or complex data types such as full-motion video and voice annotations;
- be accessed and modified by many people simultaneously (if they have permission to do so)'.

This definition only applies to electronic documents.

Fukkink and Ramackers [1991] and Dur [1992] use a concept referred to as information-object, including documents. Dur defines an information-object as 'an object processed by workers during information processing tasks'. This definition strongly appeals to documents as a vehicle for business processes. The concept of information-objects emphasizes the co-ordination between organizational processes and merely distinguishes the information being exchanged, consequently disregarding the used media. Dietz [1994] uses a similar approach in business modeling. He analytically separates the informational from the physical dimension of documents. He refers to the informational and documental levels of business processes and consequently connects these to the objectives of an organization: the essential level. At the documental level, Dietz defines an organization as a system of actors producing, storing, transporting, and destroying documents.

These definitions clarify the different carriers of documents (e.g. paper, floppy), and several types of documents, using different media (e.g. graphics, voice, video).

The carrier of a document is important due to two reasons:

1. It determines the possibility to automatically process the information contained by a document. A paper document can not be automatically processed, unless when being converted to an electronic document by scanning.
2. It determines the possibility to manipulate data after being recorded. Manipulating data recorded on paper without leaving a trace is rather difficult, while data recorded on erasable magnetic media are relatively easy to manipulate without leaving traces.

Based on these definitions it can be concluded that documents can contain any kind of information<sup>8</sup>: text, tables, pictures, etc. This is the information content of a document, which can be either well-structured (e.g. tables) or ill-structured (e.g. plain text). In well-structured information, the meaning of the information is determined by the place of the data on the carrier. This is not the case regarding ill-structured information [Van der Meer 1994]. Besides information intended for human consumption, electronic documents contain additional information revealing the manner of presentation.

The various definitions of a document show the difficulty of constructing a general definition of a document. It is important to notice that the word document is in fact a collective term. That is why it is often used with an additional adjective, such as *official* document, *electronic* document, *multi-media* document, etc.

Derived from the definitions of documents presented above, three dimensions of documents are distinguished:

- *carrier* dimension      The way a document is physically implemented (e.g. electronically processable or not, and easy to manipulate or not).
- *information* dimension      The idea, thought or information a document contains, either well- or ill-structured.
- *presentation* dimension      The possible presentations of the information, using dedicated tools (e.g. the presentation being either straightforward or advanced). Dedicated presentation tools often require additional meta-information.

HTML documents, for instance, may contain textual information and hyperlinks. The hyperlinks are part of the presentation dimension, while the textual information is part of the information dimension. HTML documents are always electronic (carrier dimension). The next section will add three more dimensions.

### 2.1.2 Manipulation of documents

The previous section presented three dimensions relating to the document as an entity: its information content and its appearance, both physical and the possible presentation. This section focuses on the manipulation of documents and its informational content.

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<sup>8</sup>It would be preferable to refer to the data a document contains, given the fact that data only become information when used by humans in mental processes. For convenience's sake, 'information' is used in this thesis. In case the difference is of importance 'information content' and 'data content' of documents will be used.

Three perspectives on organizations: micro, meso and macro, are presented in chapter 1. The micro perspective focuses on tasks performed by individuals and groups. Especially in information intensive organizations, information is implemented in the execution of tasks. Consequently, the information content of documents is manipulated or treated in order to perform individual tasks.

A number of authors have categorized the ways documents can be manipulated. Examples of classes are:

- to generate, to edit, to move, to interpret, to record, to style, to store, to select, to retrieve, to reproduce, to distribute, to destroy [Wentink and Zanders 1985 following Bosman 1981];
- to create, to edit, to obtain, to reproduce, to make accessible, to store, to consult, to lend, to destroy, to move [BiZa 1993];
- to talk, to listen, to observe, to read, to write, to draw, to process, to store, to retrieve, to delete [Morrison and Vogel 1991].

Van der Meer [1994] categorizes document manipulation based on the differences between creation, distribution and usage. He distinguishes the following categories:

1. Creation: (a) to conceive, to edit, to create, (b) document production control, document process management.
2. Distribution: (a) distribution of information, to publish.
3. Usage: (a) to select, (b) to ensure the availability of information, to implement a query structure, to trace, (c) information management, to lend, to remove.

A number of the categories mentioned earlier relate to the use of the information content of documents. Examples are: to edit, to interpret, to consult, to write, to draw, etc. Other categories relate to the distribution of information and the exchange of documents. Finally, a number of categories relate to the management of documents. For instance: to store, to retrieve, to lend, to delete, to make accessible, to ensure the availability of information, etc. Consequently, three more dimensions of documents can be identified:

- *modification* dimension      The manner in which the information content of documents can be altered (e.g. to edit, to consult, etc.).
- *exchange* dimension      The way the document and its information content can be exchanged (e.g. to send, to lend, etc.).
- *management* dimension      The management of the document and its information content (e.g. to make accessible, to delete, etc.).



The working definition of documents used in this thesis is derived from the document dimensions.

**Document** A set of recorded information, regardless of its carrier, which has or had possibilities for modification and exchange, and is manageable.

The definitions of a document management system, a record and a repository are derived from the definition of a document.

**Document management system** A document management system is a computerized system which holds information concerning documents. A document management system may also contain the actual documents. A document management system is the technological part of electronic document management (see section 1.1.1).

**Record** A record is a document which is registered or recorded in a document management system<sup>9</sup>.

**Repository** A repository is a store of records.

Consequently, a document is referred to as a record when meta-information regarding the document is recorded. A combined number of records is called an archive. It is stressed that a 'pile of paper' or a 'directory with electronic documents' is not a repository since its documents are not registered: it is merely a 'pile of documents'.

## 2.2 Organizational processes and the use of electronic documents

The previous section identified six dimensions of documents, three relating to the actual document, and three relating to document manipulation. Section 1.2.2 shows that a document's information content and the way it is manipulated, closely relate to organizational processes and output. Consequently, the necessity of studying organizational processes and output in order to identify characteristics which influence the use of documents seems obvious. In this section, the characteristics of organizational processes are examined and related to the use of documents.

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<sup>9</sup> Defined in the traditional paper-based way, a record has the following characteristics: it is complete and independent, it has a stable visible format on which the data are permanently recorded, it has a clear life-cycle, and a clear retention period [Bikson and Frinking 1993, p.86].

### 2.2.1 Organizational processes

The focus on organizational processes in this thesis is determined by the need to identify the modification and exchange of documents. Consequently, a model of an organizational process should identify units that subsequently modify documents or between which documents can be exchanged. Depending on the level of analysis, these units consist of organizations, departments or (a group of) individuals.

The three perspectives on organizational design and improvement, the micro, meso and macro perspective presented in section 1.3, focus on different aspects of organizations. In the study of organizational co-ordination, Van Eijck [1996] has developed a conceptual framework enabling the simultaneous study of the three perspectives with a focus on information exchange. Information exchange is often implemented by document exchange. The conceptual framework constructed by Van Eijck [1996, pg. 55] is therefore useful to studying document exchange. This framework is shortly presented below and extended to the study of document modification.

#### *Macro perspective: organizational chain*

From the macro perspective, two or more organizations interact by exchanging documents. The output documents of one organization may form the input to another organization. In other words, a business process of one organization may be linked to another by document exchange. This linkage is merely possible by mutual adjustment of processes, often formalized in some kind of agreement which specifies why, how and which information is exchanged.

An organizational chain is involved in executing the Individual Rent Subsidy (IRS) Program. At an operational level, three organizations are involved in processing individual rent subsidy applications: a housing corporation, a municipality and the Ministry of Housing. These organizations jointly form the organizational chain, each assigned its own responsibility. The housing corporation is responsible for the intake of applications and additionally assists tenants with filling in their application forms. This form is forwarded to the municipality. The municipality is responsible for quality control, which is executed by comparing the application form to the population registration. The Ministry decides on the amount of subsidy.

Van Eijck stresses the resemblance of inter-organizational information exchange and intra-organizational exchange. From his point of view, focusing on organizational co-ordination, the only difference is the crossing of organizational boundaries. To avoid problems between organizations, the

crossing of boundaries is either embodied in a formal agreement or regulated by law. From a documental perspective, documents exchanged between organizations have a higher evidential value compared to documents exchanged within one organization. Consequently, copies of these documents are usually stored and document exchange is registered.

*Meso perspective: processes*

Documents exchanged within the organizational chain are the output of processes executed by an organization. The meso perspective focuses on organizational processes. Organizational processes are often defined as a sequence of actions [Davenport 1993, p.5] or a sequence of activities [Van Eijck 1996, p.56]. An actor takes actions and performs activities. It is important to notice that an activity<sup>10</sup> is defined with a clear beginning and ending. The beginning is an external or internal trigger; by applying for subsidy, a tenant triggers an intake process, and running out of stock triggers a purchase process.

Activities are always performed by an actor, for instance a department or a (group of) individuals. A process includes one or more activities which are performed by one or more actors. The co-ordination of activities performed by two or more actors requires information exchange, often embodied in documents. Consequently, the meso perspective focuses on intra-organizational document exchange. This is executed by the identification of actors taking part in the process and performing activities. One activity might be executed by several actors, while the actual execution will always be performed by one actor.

The meso perspective on processes is illustrated by a housing corporation processing IRS applications. Besides assisting tenants with filling in their applications, a housing corporation calculates the expected subsidy. Each tenant is scheduled for an appointment at the start of the subsidy year. In case the complexity of the application is above average, the tenant is referred to an expert of the housing corporation. The IRS process of the housing corporation includes three activities: scheduling an appointment, assisting the tenant and expert-consulting. The expert is an example of an actor.

*Micro perspective: task and decisions*

During the execution of an activity, decisions are made and tasks are performed: from the micro perspective, tasks and decision are the atomic

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<sup>10</sup> In this perspective actions and activities are regarded as synonyms.

units of an activity. Decisions determine when, and in which sequence tasks are executed. When executing tasks, actors operate on any kind of object: products or a piece of information. Van Eijck calls these objects 'items'<sup>11</sup>, of which he provides the following examples: documents, memos, files and messages. The possible sequence in which tasks and decisions are carried out, is represented in the task structure [Bots 1988, Dur and Sol 1991].

Re-using the IRS program, tasks and decisions are illustrated by an activity named 'filling in the form'. During the housing corporation's appointment with the tenant to fill in the application form, information supplied by the tenant is checked and the expected subsidy is calculated. Furthermore, the tenant is supplied with information concerning the processing of the application. The activity 'fill in the form' includes three tasks: checking supplied information, calculating expected subsidy and providing information. It also includes one decision: is all the information available?

Level of analysis	Object of analysis	Atomic units	Execution units
macro	organizational chain	process	organizations
meso	process	activity	organizational unit (e.g. department)
micro	activity	decision, task	one individual or a group of individuals which operates as one entity in terms of information processing

Figure 2.1 Levels of analysis, atomic units and execution units

From a documental point of view, the micro perspective on organizations shows the use of information. In case this information is represented while using the documents, the micro perspective shows the modifications. Document exchange is not connected with the micro perspective, since tasks and decisions are executed by one actor. In case a task is executed by more than one actor and consequently requires document exchange, the task includes aspects which have to be modeled to the micro perspective on organizations. Figure 2.1 shows which concepts are used at which level of analysis.

The three levels of analysis show an increasing level of detail. Figure 2.2 shows the connection between the organizational chain, process and activity.

<sup>11</sup>Regarding information intensive organizations, Fukkink and Ramackers [1991] and Dur [1992] respectively refer to information-objects and information-items. Sometimes 'activity driver' is used.

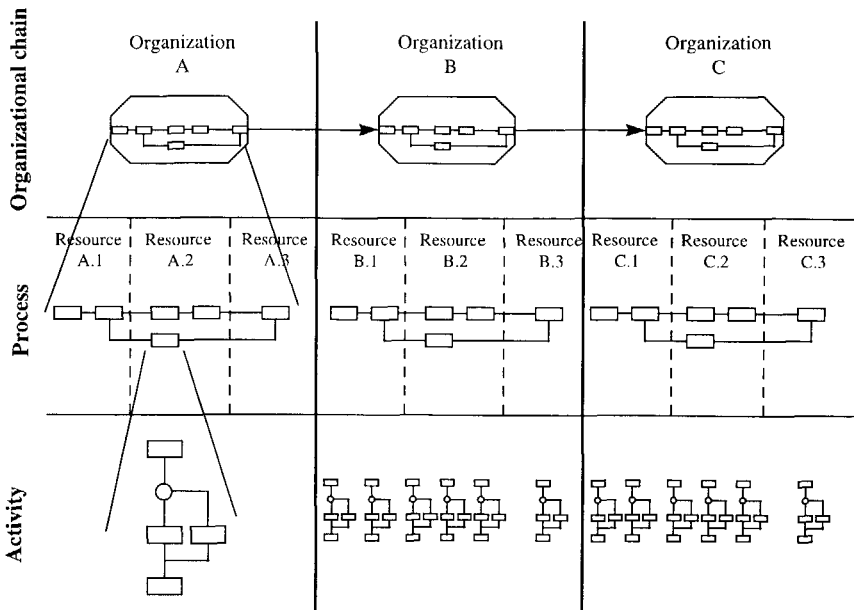


Figure 2.2 Connection of organizational chain, process and activity

From a documental point of view, a process and an organizational chain are similar due to the modeling of document exchange. Internal document exchange is shaped in a process model, while the organizational chain models external document exchange. Regarding internal and external document exchange, a difference occurs in the evidential value. The evidential value of a document exchanged between organizations will be higher compared to a document merely exchanged between departments. This is due to the formal character of relations between general organizations in comparison with the less formal relations of departments within one organization. Derived from the evidential value of documents, external document exchange requires a high level of registering and saving copies, whereas internal document exchange requires a relatively low level. Internal documents with a high evidential value may also require registering and saving copies. A less strict procedure for registering and copying, however, may be accepted.

### 2.2.2 Archetypes of organizational processes

It is not always possible to structure organizational processes in advance. For example, Simon [1973] and Mintzberg et al. [1976] state that 'unstructured' decision processes contain a form of fundamental structure and basic activities. They also state that, despite this fundamental structure,

the sequence in which these basic activities will be executed, is difficult to predict for a certain problem situation. Accordingly, the sequence of problem solving activities is not clear in advance. Bots [1988, p.21] refers to the 'programme' by which a problem situation can be solved. If this programme is clear, the process in which the problem situation can be solved contains a clear structure. In other words, the process is well-structured.

Sol [1992] and Sprague [1993] distinguish type I tasks (high degree of structure; routine tasks) and type II tasks (low degree of structure; ad hoc tasks). They emphasize that these types are extremes of a sliding scale. Panko [1984] and Sprague [1993] summarize a number of aspects in which type I and type II tasks differ. Relevant factors are the amount of transactions, the structure of the problem, the focus of the tasks (how to act? or what to do?), the focus of the output (efficiency or effectiveness), and the structure of the information processed. Interestingly, with respect to the use of information and the output of the task, Panko and Sprague conclude that the predictability of type I tasks is higher than that of type II tasks. As a result, the manipulation of documents is more difficult to predict for type II tasks than for type I tasks. Hence, the difference between type I and type II tasks is the predictability of both the course of action and information use. Section 1.2.2 argues that the information content of documents and the document exchange are closely related to an organization's processes and output. If predicting the course of action is difficult, predicting the information structure and the information content of documents and document exchange will be difficult as well.

The predictability of the course of action is applied to activities, processes, and organizational chains. If the sequence of activities of a process and the sequence of organizations involved in an organizational chain are unknown prior to execution, both the process and the organizational chain will be ill-structured. Consequently, during the execution of a process, at the end of an activity the following activity will have to be determined. An example being the answer to the question 'Which department does this have to be sent to?'. These kinds of processes are structured 'on the fly'. In case the sequence of activities is difficult to predict, predicting document exchange will be difficult as well.

The predictability of the information content of documents and document exchange is of importance to the design of supporting IT tools. The information content of documents being well-structured, enables the use of dedicated tools which present the information content of documents to users tuned to their tasks. The same applies to document exchange. If document

exchange is clear, prior to the execution of organizational processes, electronic documents can be routed automatically through the organization.

Compared to structured activities, ill-structured activities use more ill-structured information [Panko 1984, Sprague 1993, Van der Meer 1994]. Furthermore, ill-structured activities require a wider range of information sources and more flexible supporting tools [Nutt 1984]. Structured activities use a limited number of information sources known prior to process execution. Consequently, it is possible to list documents used in a structured activity.

It is important to notice that both structured and ill-structured activities are archetypes. Completely structured or ill-structured activities seldom occur in real life. A certain activity will always include some structured and some ill-structured parts. IT tools especially contribute to organizational effectiveness when the implementation of these tools is combined with a redesign of the supporting organizational process [Sol 1992]. In case IT tools are used in order to support ill-structured processes, one will try to structure these processes. By doing so, one will also try to structure the information used in these processes.

### **2.3 Analyzing document-based processes**

The object of this research is electronic documents. A working definition of documents, which also includes electronic documents, is provided in section 2.1. Our perception of organizational processes which use documents is described in section 2.2. The archival approach to documents focuses on the actual documents, reaching beyond the organizational process in which they are used (see section 1.2.1). A process-oriented approach to documents neglects the significance of documents reaching beyond that process (e.g. the cultural value of documents). In order to study document-based processes with the objective to design supporting tools, both the documents and the organizational process should be taken into account, constructing a so-called 'rich picture' of the design situation [Checkland 1981].

Two different approaches can be followed: starting with documents or starting with the process: a 'document-oriented approach' or a 'process-oriented approach'. Process-oriented approaches to systems design are frequently advocated [Sol 1984 and 1992, Davis and Olson 1985, Dietz 1994]. This will be elaborated on by jointly applying a document-oriented and a process-oriented approach to document-based design situations. Hence, when analyzing document-based processes, both the organizational process and the document should be examined. Figure 2.3 summarizes the aspects which should be taken into account. It is already mentioned that internal

document exchange is shaped in a process model, while the organizational chain models external document exchange (see section 2.2.1). Consequently, figure 2.3 does not show 'document exchange'. The significance of documents is already discussed in section 1.2.1.

### Analyzing document-based processes

Document	Process
<ul style="list-style-type: none"><li>• carrier dimension</li><li>• information dimension</li><li>• presentation dimension</li><li>• modification dimension</li><li>• management dimension</li><li>• significance of documents</li></ul>	<ul style="list-style-type: none"><li>• organizational chain</li><li>• process structure</li><li>• activity structure</li></ul>

Figure 2.3 Aspects taken into account when analyzing document-based processes

#### 2.4 Research objective and questions

Section 1.2.1 shows that the PIVOT approach to document management takes critical organizational processes as a starting point for selection and retention of documents. The aim of document management from an archival point of view is to ensure the reconstruction of any critical process. Hence, instead of limiting EDM to a certain process, a variety of organizational processes should be supported. From an organizational point of view, EDM should contribute to an organization's performance (section 1.2.2). This requires tuning EDM with the process in order to make sure that documents are available when needed.

Both the archival and the organizational perspective on EDM lead to opposite requirements regarding EDM, both considering the supporting tools and procedural measures. From the archival perspective, EDM should accommodate universal use, supporting a variety of organizational processes. Close tuning of EDM to organizational processes will reduce its universal use. The organizational perspective requires close tuning of EDM to the process.

This research deals with these opposite requirements by taking the universal use of EDM as a starting point. Due to its universal use, EDM is regarded an infrastructural provision. In order to emphasize its universal use and prevent confusion with EDM tools, the phrase 'electronic document infrastructure' is used.



The electronic document infrastructure is defined in line with the approach to EDM, which includes both technological and procedural measures (see section 1.1.2).

**Electronic document infrastructure** An electronic document infrastructure is a combination of technological, informational and procedural measures, supporting a variety of organizational processes regarding the management and control of electronic documents.

The objective of this research is to construct a theory regarding the design of electronic document infrastructures. This needs to be executed on the condition of meeting archival demands concerning the selection and retention of electronic documents, while contributing to an organization's effectiveness and efficiency. It is mentioned that the concept 'infrastructure' is contextual. In this thesis it is used in the context of organizations.

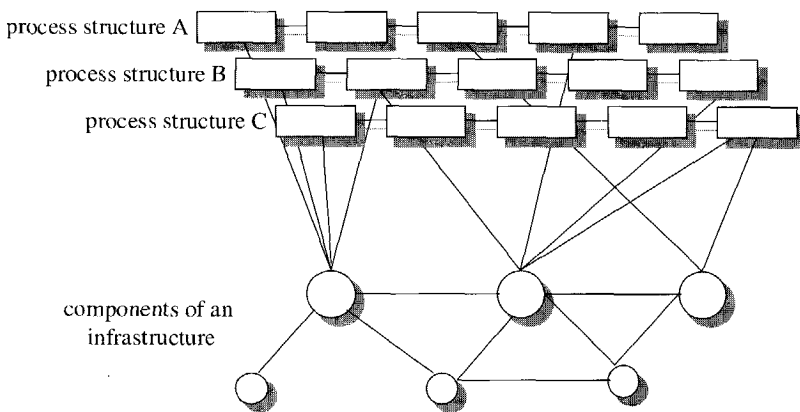


Figure 2.4 Processes supported by an infrastructure

In general, an infrastructure is characterized by universal use [Sanders 1994, p.4]; in this particular case a variety of organizational processes. This means that the components of the electronic document infrastructure (technological, informational and procedural) will be used in a variety of processes. This is shown in figure 2.4 [after Uijttenbroek et.al. 1995, p.39].

An infrastructure needs to be multi-usable and solid, age slowly and requiring little maintenance. The functions and the limits of an infrastructure have to be clear. The first research question focuses on this in terms of processes and supporting functions.

**Research question 1:**

*Which capabilities should an electronic document infrastructure possess in order to support a wide variety of organizational processes?*

The functions of an electronic document infrastructure are set to support business processes. These functions should comply with the process characteristics and document use. Consequently, the organizational processes that can be supported by an electronic document infrastructure have to be apparent. This is the subject of the second research question.

**Research question 2:**

*Which kinds of organizational processes, categorized by their characteristics and document use, can be supported by an electronic document infrastructure?*

In designing an electronic document infrastructure, one has to balance optimal process support and the universal features of the infrastructure. This consideration emphasizes the multi-usability of an infrastructure. Furthermore, specific attention should be given to the solidness, the speed of aging and the maintenance of the future infrastructure. Compared to the design and implementation of a dedicated application, the considerations mentioned above are relatively more important to the design and implementation of an infrastructure. The following research question concentrates on important decisions regarding the design of an electronic document infrastructure.

**Research question 3:**

*How can one balance optimal process support and universal features of the infrastructure?*

An infrastructure has to be 'worth its money': an electronic document infrastructure should somehow improve organizational performance. In 't Veld [1988] summarizes six criteria of organizational design: efficiency, effectiveness, quality of work, innovative power, flexibility, and manageability. These criteria can be implemented in order to study the impact of an electronic document infrastructure. This research solely concentrates on effectiveness, efficiency and manageability. The reasons for this choice are:

- A study of the quality of work demands a view on organizational processes which focuses on ergonomics and working conditions.
- A study of innovative power and flexibility includes market conditions and requires material for comparison.

**Research question 4:**

*What is the contribution of an electronic document infrastructure to an organization's effectiveness, efficiency and manageability?*

The objective of this research is to construct a theory regarding the design of an electronic document infrastructure. This theory will contain instruments, such as heuristics, procedures, methods, and tools, to solve the problems emerging due to the use of electronic documents. The theory will structure the set of instruments, constructing a coherent approach to the design and implementation of an electronic document infrastructure. This is in fact a methodology for a certain problem area, which in this research means the management of electronic documents [Sol 1982].

*An analytical framework for the design of methodologies*

An analytical framework for the design of methodologies is given by Sol [1984, 1985]. This framework classifies methodologies by ways of thinking, modeling, working, controlling, and supporting. Notwithstanding the fact that this framework is intended to analyze existing methodologies, it is also used to construct methodologies for new problem areas [e.g. Van Meel 1994, Van Eijck 1996]. Moreover, this research will use this framework, which is described below, in a descriptive way. Chapter 6 applies this framework to the problem area.

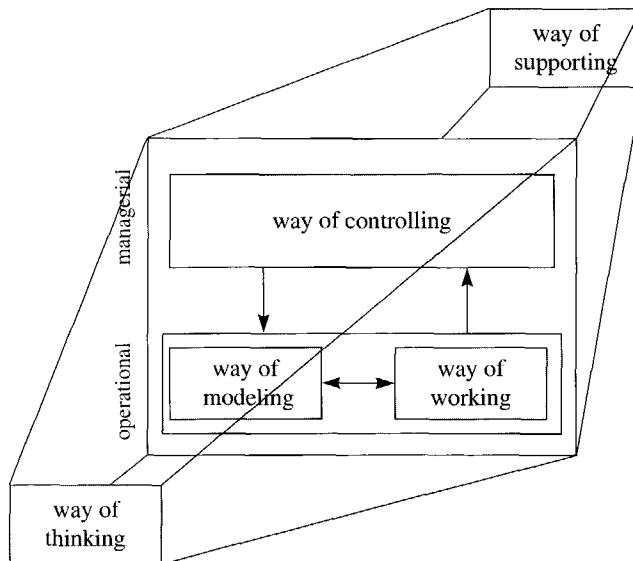


Figure 2.5 Framework for methodologies [after Wijers, Seligmann and Sol 1992]

Figure 2.5 provides the reader with an overview of the framework, showing its components. Sol [1984, 1985] states that methodologies always have an underlying perspective or 'Weltanschauung', and a 'construct paradigm'. These are represented in the *way of thinking*. The way of thinking determines the way in which problems are perceived and what kind of solutions are taken into account. It also sets the problem area a methodology can be successfully applied to.

The *way of working* structures the strategy which determines the manner in which information systems are developed and implemented. In fact, the way of working is the subject of the third research question, focusing on important design and implementation decisions. Topic of the second research question is *the way of modeling*. Representing real-life situations in a model implies the reduction of complexity. This is executed by making decisions concerning aspects which should be modeled in order to be able to grasp the problem. Based on ways of thinking, these aspects are limited to process characteristics and document dimensions. The ways of working and modeling are the operational level of system design. The managerial level is represented by the *way of controlling*. It includes planning and plan evaluation, establishing the project by indicating how the various persons and groups should interact and how generally limited resources should be employed and allocated. The actual design and implementation process can also be supported by automated tools. The collection of tools supporting the process of design is being referred to as the *way of supporting*. Supporting tools should fit the ways of working, modeling and controlling, and correspond with the way of thinking.

## 2.5 Research approach and outline of the study

### 2.5.1 Research approach

Chapter 1 shows that problems emerging due to the use of electronic documents are rather new and multidisciplinary. Additionally, little theory on these problems exists. The objective of this research is to build a multidisciplinary theory on how to solve these new problems.

#### *Research approach*

Theory building requires another research approach than theory testing [e.g. Checkland 1981, Galliers 1991]. Research aimed at theory testing makes use of deductive reasoning and quantitative research instruments, thereby relying on the researcher's objective observations of the phenomena studied, while focusing on 'repeatability', 'experimental control' and 'analytical rigor'.

This kind of research is part of the so-called 'hard' positivist research tradition [Checkland 1981]. This tradition uses research instruments such as 'laboratory experiments', 'field experiments' and 'surveys'.

Research aimed at theory building makes use of inductive reasoning and uses qualitative research instruments which are common to the so-called 'soft' interpretivist research tradition. In this tradition, one relies on the researcher's subjective interpretation and understanding of the subject studied, thereby focusing on 'shared norms and practices', 'organizational culture' and 'common language between actors'. This research tradition uses research instruments such as 'action research', 'field studies' and 'case studies'.

The information systems area is characterized by constant technological change and innovation. Consequently, new problems emerge requiring new theories [Sol 1982, Benbasat et.al. 1987, Orlikowski and Baoudi 1991]. First, researchers study the manner in which organizations deal with these new IT-related problems in practice. As a result, these studies are the basis for the development of prescriptive guidelines to solve the problems mentioned. This explains the increase of inductive research in the information systems area occurring since the late seventies [Davies and Myers 1994]. Rockart and Flannery [1983] illustrate this line of reasoning with the management of end-user computing technology. Prior to the formulation of a sound theory on the management of end-user computing, a number of case studies were conducted. This line of reasoning also applies to EDM. Consequently, the inductive research approach is used in this research.

#### *Inductive-hypothetical research approach*

The inductive-hypothetical research approach [Churchman 1971, Bosman 1977, Sol 1982] is applied successfully to study problems which require new theories [De Jong 1992, Van Meel 1994, De Vreede 1995, Van Eijck 1996]. Due to the following reasons, Sol [1982] advocates the inductive-hypothetical research approach:

- it adopts an existing problem as a starting point and emphasizes problem specification;
- it opens up possibilities for multidisciplinary problem specifications, and combines theory and practice;
- it stimulates generating alternative solutions for problem situations;
- it generates ideas regarding possible mechanisms operational in the problem area;

- it permits feedback and learning in one research cycle, enabling the evaluation of ideas regarding the mechanisms operational in the problem area.

Consequently, this research approach fits the study of problems which require a new solving theory.

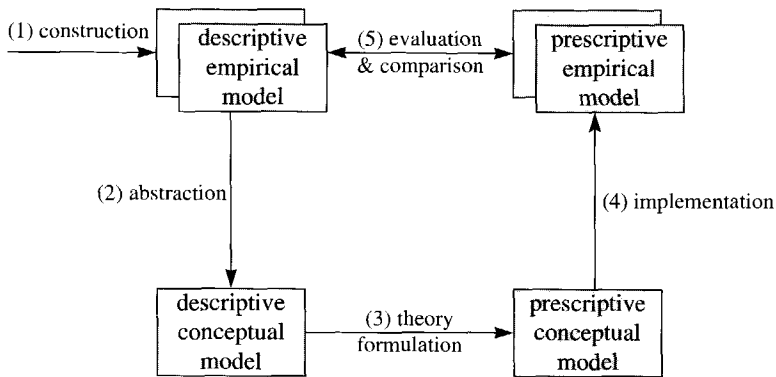


Figure 2.6 The inductive-hypothetical research strategy [after Sol 1982]

Figure 2.6 shows the inductive-hypothetical research cycle. A number of models are constructed in this research cycle. The first model, the *descriptive empirical model*, describes a perceived situation in a specific area of interest (e.g. electronic documents in organizations) from a specific point of view (e.g. management of electronic documents). Analyzing these perceived situations, provides a detailed insight in, and a better understanding of the research area studied. Quite often, more than one problem situation is studied in order to get insight into the different manifestations of the problems, leading to more than one descriptive empirical model. The *descriptive conceptual model* is based on an abstraction of a number of descriptive empirical models. The descriptive conceptual model describes the problems encountered in a generic way, consequently eliminating situation related matters. This model triggers possible solutions. These solutions are combined in a theory presented in the prescriptive conceptual model. The latter is also described at a generic level: it does not contain situation related matters. Testing the theory requires an implementation of the prescriptive conceptual model. After elaboration on this model, one or more prescriptive empirical models are created, forming an application of the proposed theory. The effectiveness of the theory is evaluated by comparing the descriptive to the prescriptive empirical models.

*Research instruments*

Case studies are often used in the inductive-hypothetical research cycle [De Jong 1992, Van Meel 1994, De Vreede 1995, Van Eijck 1996]. The case study is considered apt to derive theories from, and to examine phenomena in their natural settings [Benbasat et.al. 1987, Yin 1990, Rosenthal 1994]. Hence, it is an important research instrument to conduct inductive research: a case study research focuses on 'how'- and 'why'- questions. The objective of this research is to build a multidisciplinary theory regarding EDM and the manner in which it can be supported by an electronic document infrastructure. Section 1.1 showed the increase of electronic documents and the relating problems. When constructing a theory, electronic documents need to be studied in their natural settings. Consequently, this research uses the case study approach.

The use of a case study as a research instrument contains some risks, such as low possibilities for generalization, little control of the experimental conditions and the generation of a large amount of documents [Miles 1979]. In order to overcome these risks, Yin [1990] advocates the design of a case study. A case study design should contain the following elements [Yin 1990, p.29]:

- a study's question;
- its propositions, if any;
- its units of analysis;
- the logic linking the data to the proposition;
- the criteria for interpreting the findings.

The first element is described in section 2.4, the research objectives and questions. Our way of thinking, presented in chapter 1 and 2, holds the propositions of this research. As can be derived from chapter 1, the object of this study is organizations experiencing problems with EDM. In order to fully understand the problems they encounter, multiple units of analysis are used within a single case study. These are documents from a micro perspective, business processes from a meso perspective, and the organizational chain from a macro perspective.

Section 2.3 describes a framework for analyzing document-based processes, used to linking the data to the propositions. The findings will also be interpreted in relation with the framework. The criteria for evaluation are formulated in research question 4: an organization's effectiveness, efficiency, and manageability.

According to Benbasat [1987], three categories of qualitative research instruments exist. These are considered case studies: application description, case study research and action research. Application descriptions are written by practitioners and contain detailed information on the author's experiences regarding a certain application or project. Although the focus of the project is to fulfill a clear assignment, for example the implementation of a financial application, these descriptions often lack a clear set of propositions. Case study research holds a clear research objective and relates the findings of the study to a proposed or existing theory. Hence, research questions are formulated prior to conducting the case study. In a case study, researchers are observers rather than participants. In action research, the researcher has become a participant in the object of study, because he or she wants to evaluate a certain intervention technique. The original intention of the researcher is to conduct research while inflicting change [Susman and Evered 1978]. Unlike a case study researcher, the action researcher is not an independent observer, but a participant. In this case, the process of change becomes the subject of research. The advantage of action research is the in-depth and first hand understanding one obtains. A disadvantage is the potential lack of objectivity stemming from the researcher's interest in effecting a successful outcome of the intervention.

This research uses both case study research and action research. The case study research, as defined by Benbasat [1987], is used to gain insight in the existence of electronic documents and the problems connected. The results of the case study research are implemented in the descriptive conceptual model. A rich natural setting is important for generating theories. That is why the cases selected for the case study research contain a wide variety of different processes and document use (see figure 2.8). Action research is used to evaluate our theory described in the prescriptive conceptual model.

Three case studies were conducted within one organization: the Ministry of Housing, Spatial Planning and the Environment. This introduces the risk of case contamination [Rosenthal and 't Hart 1994]. Case contamination involves unintended and unexpected relations between case studies which were considered being independent. This reduces the possibilities to generalize conclusions to similar situations.

In this research, the risk of case contamination is eliminated because of the following reasons:

- The organization where the proposed theory is tested, is different from the organization where the cases used for theory construction are conducted.



- Multiple units of analysis are used: documents from the micro perspective, and processes from the meso and macro perspective. Our unit of analysis is not an organization.
- Regarding the structure of information, activity and process, the organizational processes studied in the cases are different (see also figure 2.9). This is of great importance because of the plural use of the infrastructure on which the theory focuses (see section 2.4).
- Each case is conducted within a different department of the Ministry of Housing, Spatial Planning and the Environment.

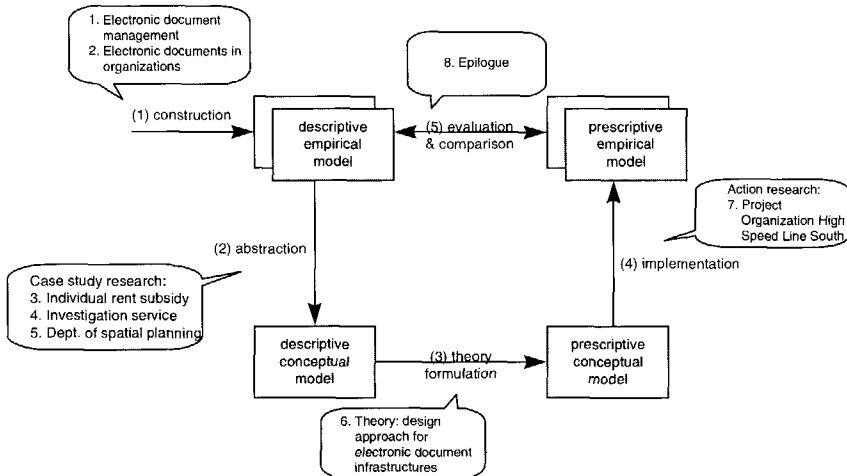


Figure 2.7 Outline of the research project

## 2.5.2 Outline of the study

Figure 2.7 shows the outline of the research project. This is an extension of figure 2.6, showing the inductive-hypothetical research strategy, with so-called text-balloons which refer to a chapter of this thesis. Three case studies were conducted within the Ministry of Housing, Spatial Planning and the Environment. Each of these cases focuses on a different type of organizational process. Figure 2.8 provides an overview of the cases and the variation of organizational processes studied regarding the information structure, the activity structure and the process structure. These three cases are the foundation of the descriptive conceptual model. The cases are presented in chapters three, four and five. Each of these chapters ends with a number of conclusions regarding EDM and possible functions that need to be fulfilled by an electronic document infrastructure.

The proposed theory for the design of an electronic document infrastructure is presented in chapter 6. It is important to notice that the primary requirement of a design is that it operates, not merely in theory but mainly in practice [Checkland 1981]: the proof of the pudding is in the eating.

Case	structure of information	activity structure	process structure	Organization
Individual Rent subsidy	+	+	+	Ministry of Housing, Spatial Planning and the Environment.
Investigation Service	-	-	+	
Department of spatial planning	-	-	-	
Design and implementation of the infrastructure	-	-	-	Project Organization High Speed Line South

Figure 2.8 Cases classified (- = ill-structured, + = well-structured)

The application of the proposed theory at the Project Organization High Speed Line South (HSLs) is presented in chapter 7. The electronic document infrastructure is implemented in a pilot-project using an EDM application. The general management of HSLs decided to implement the infrastructure company-wide, based on a positive evaluation of the pilot project. The pilot project is presented in chapter 7.

At the start of the HSLs-case, the use of electronic documents was measured, including the time employees spent on EDM, and existing problems were listed. After the implementation of the electronic document infrastructure, this measurement was repeated. This enabled the drawing of conclusions regarding the effects of the electronic document infrastructure with respect to the effectiveness, the efficiency and the manageability of organizational processes.

### **3. Case 1: Structured document usage: the individual rent subsidy program**

The Individual Rent Subsidy (IRS) program<sup>12</sup> and the Student Grants program<sup>13</sup> are the only major programs in the Netherlands a Ministry is responsible for at an operational level. Other programs, such as social security, are the responsibility of local authorities. The IRS program is one of the few programs where a Ministry maintains direct contact with citizens.

The case study at the Ministry of Housing, Spatial Planning and the Environment of the Netherlands was conducted in 1995. The object of this research was the execution of the IRS program from January 1994 until July 1995. While the IRS is the responsibility of the Ministry of Housing, several organizations are involved in the execution of the IRS program, municipalities and housing corporations being the most important organizations. This case study is described in Uijenbroek and Sol [1995, 1997]. One should realize that the information presented in this chapter is based on the findings of 1995. The instruments used to collect data are presented in appendix A.1.

#### **3.1 Individual rent subsidy program: policy and implementation**

##### *Policy*

The major objective of the housing policy in the Netherlands is ensuring the availability of quality housing to low-income households at affordable prices [VROM 1994]. This policy is implemented by means of subsidies, the largest budget managed by the IRS program. Other subsidy programs are House Related Subsidies<sup>14</sup> and Location Related Subsidies<sup>15</sup>.

The IRS is granted to individuals who meet the following requirements [VROM 1994]:

- being 18 years or older;
- occupying a rented house;
- not paying any wealth tax;
- complying with income and rent regulations of the IRS program.

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<sup>12</sup> In Dutch: Individuele Huursubsidie (IHS)

<sup>13</sup> In Dutch: Studiefinanciering (SF)

<sup>14</sup> In Dutch: Besluit Woninggebonden Subsidies (BWS)

<sup>15</sup> In Dutch: Besluit Lokatiegebonden Subsidies (BLS)

At the end of the 1980s the greater part of deregulation and privatization of the housing market occurred. This led to a privatized housing sector in which housing corporations determine the availability of affordable quality housing to low-income households. Furthermore, housing corporations retain considerable freedom in determining rent-levels according to market conditions [VROM 1994]. In this market-oriented approach, the IRS is intending to keep its role as a safety-net for the housing market. As a ground rule, this means that the market implements the objectives of the housing policy. The IRS on the other hand, supplies a safety-net for tenants paying too much rent in proportion to their income. The span of this safety-net is restricted. A person renting a house too expensive in proportion to his income, will only receive subsidy in case of a lack of housing. Regional rent committees evaluate the market situation and assess the availability of more appropriate housing. In 1995, almost one million households received rent subsidy. With an average subsidy of about f 2,000.- this amounts to an annual expenditure of f 2 billion.

The IRS program and its implementation are a topic of discussion at a political level due to budget cuts (in 1995 it was decided that the IRS budget would be cut by 10%), major decentralization operations within the Dutch government and the possibilities of leading-edge technology. Currently, new organizational forms for implementation of the IRS program are being studied.

#### *Implementation*

The implementation of the IRS involves a central governmental agency, all 633 municipalities in the Netherlands and about 2,000 private rental organizations, such as non-profit housing corporations. The HIS<sup>16</sup> department, a division of the Ministry of Housing, is responsible for the final approval and payment of subsidies. HIS has about 340 employees, 285 performing operational tasks, 45 supporting these operations (e.g. IT support, financial management, etc.) and 10 being involved in strategy and instrument development. HIS was re-organized by the end of the eighties. During this re-organization, new contemporary IT was introduced, in connection with organizational principles such as empowerment and task groups [Verdaas 1990].

In order to process IRS applications, HIS uses a broad distribution channel of municipalities and local housing corporations. The intake of applicants

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<sup>16</sup> After its Dutch abbreviation of 'Hoofdafdeling Individuele Subsidies', meaning department of individual subsidies

occurs on a local level: municipalities and local housing corporations filling out the forms for tenants, checking the supplied data, and calculating the expected subsidy. Several important preliminary controls concerning income, residence and rent are included on this level. Applicants should be able to substantiate supplied data with tax-return papers and excerpts of the automated population administration (GBA<sup>17</sup>). Data on rent levels are available at housing corporations and regional rent committees.

Generally, the central government pays the granted subsidy to non-profit housing corporations. The non-profit housing corporations subtract subsidy from the rent due by the tenants. This is called 'rent moderation'. To apply for rent moderation, rental organizations have to be qualified by HIS. Non-profit housing corporations are often qualified. Each month, HIS pays the subsidy to about 2,000 rental organizations which apply rent moderation. A person renting a house from a non-participating rental company, e.g. a private landlord, receives the subsidy directly by HIS every three months. A municipality distributes the subsidy monthly. When the application is not yet decided upon by HIS, the expected subsidy, calculated by the housing corporations or municipalities, is used for rent moderation. Each month, due to the rent moderation, housing corporations and municipalities receive an advance from HIS. At the end of each subsidy year, which runs from 1 July until 30 June, HIS makes up a final settlement of accounts.

In processing IRS applications, HIS uses information from the tax department in order to check data regarding income. In order to determine the fairness of the rent and the availability of cheaper housing, HIS also uses information from rent committees. Data exchange with the tax department occurs electronically. Written data are exchanged with the rent committees. The IRS applications are also hard-copies. A large part of the applications, about 70%, are continuations of previously granted subsidies. These applications are processed automatically by HIS. No additional action is taken after the applications are added to the system, unless the income and the living situation of the tenant changes. About 30% of the applications are new applications or continuations involving some changes. These applications require manual modification. Each year, HIS receives about 169,000 letters from tenants, housing corporations and municipalities, application forms excluded. Almost 80% of these letters contain additional information, whereas 20% are complaints. Processing these letters

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<sup>17</sup> After its Dutch abbreviation of 'Gemeenschappelijke Basisadministratie Persoonsgegevens'

consumes about 60% of HIS capacity, only 40% is used for processing applications.

## **3.2 Organizational chain, process and activity**

### **3.2.1 Organizational chain**

The organizational chain shows which organizations are involved in a certain process. The following organizations are involved in the execution of the IRS program:

- HIS department  
HIS is responsible for the final decision concerning applications and the payment to tenants.
- About 2,000 rental organizations  
Rental organizations are non-profit housing corporations, non-participating rental companies and private landlords. A rental organization is responsible for the intake of applications, applying rent moderation by subtracting the subsidy from the rent, which has to be paid monthly, handing over the application forms to a municipality and supplying information to HIS regarding advances and the final settlement of accounts.
- 633 municipalities  
The role of municipalities can be twofold: a rental organization, in which case the municipality owns houses, or a front office of the Ministry. If a municipality operates like a front office of the Ministry it is granted the following responsibilities: comparing supplied information to the population administration, gathering required official documents for evidence, checking presence of all required information, and forwarding the applications to HIS.
- Tax department  
The tax department is involved in the IRS program by supplying applicants' information regarding their incomes. If required, the tax department formulates an official document concerning the income of an applicant, a so-called IB60 form. The tax department also provides HIS with bulk information regarding income.
- 11 regional rent committees  
Compared with the income of the applicants, the amount of subsidy is limited. Due to the applicant being expected to move, the availability of a less expensive house limits the amount of subsidy. The regional rent committees are responsible for supplying market information regarding the availability of houses and the fairness of the rent.

- RCC and NCCW

The RCC and the NCCW are independent organizations respectively managing the computer systems of HIS and a large number of housing corporations.

- Investigation Service of the Ministry of Housing, Spatial Planning and the Environment

In case of an alleged fraud, HIS supplies the Investigation Service of the Ministry of Housing, Spatial Planning and the Environment with the appropriate file. This service conducts an investigation and tries to reclaim the subsidy paid.

In essence, rental organizations, municipalities and HIS are directly involved in processing applications. The other organizations mentioned support this process or are involved in case of disruptions or errors at the operational level. Regional rent committees are involved in case the market conditions are not clear or there are doubts about the fairness of the rent, whereas the Investigation Service is involved in case of an alleged fraud. Finally, the tax department is involved if doubts arise concerning the income of the household.

Figure 3.1 shows the information exchange within the organizational chain in case of no disruptions. It shows the primary processing of applications. The flow of money, which goes more or less opposite to the flow of applications, is shown in figure 3.2.

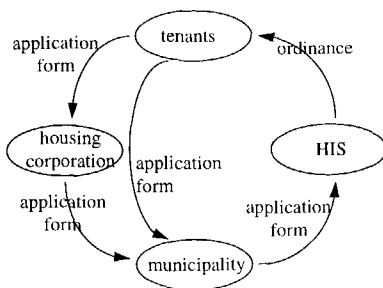


Figure 3.1 Processing applications without disruptions: the primary organizational chain

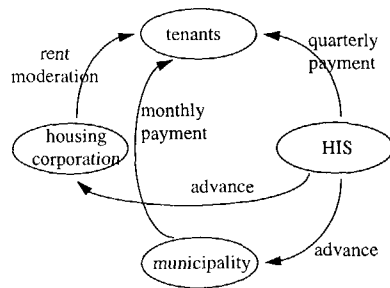


Figure 3.2 Flow of money

At the end of each month, the housing corporations and municipalities send a request for an advance to HIS. This request is based on the payments and rent moderations they expect to employ. For each subsidy granted by HIS, a

disposition is sent to both the municipality and the housing corporation. If this disposition deviates from the previously calculated subsidy, the rent moderation or the monthly payment is adjusted, and differences are settled with the tenants by the housing corporation or municipality.

At the end of the subsidy year, HIS draws up a final account regarding the granted subsidies and the advances paid to municipalities and housing corporations. Differences which might have occurred during the subsidy year (e.g. the rent moderation differs from the subsidy granted by HIS) have to be solved. In case the rent moderation appeared to be higher than the subsidy granted, the housing corporation will refund the difference from the tenant. If the settlement is final and HIS has established new differences between the rent moderation and the subsidy granted, HIS needs to recover the difference from the tenant.

Figure 3.3 shows the information exchange within the organizational chain of the IRS program, including the settlement of accounts with the housing corporations and municipalities. It also shows the involvement of organizations in case of disruptions of the primary organizational chain (the bold lines). Figure 3.3 does not show the flow of money. All information exchange is implemented using hard-copies except for the tax department's income information.

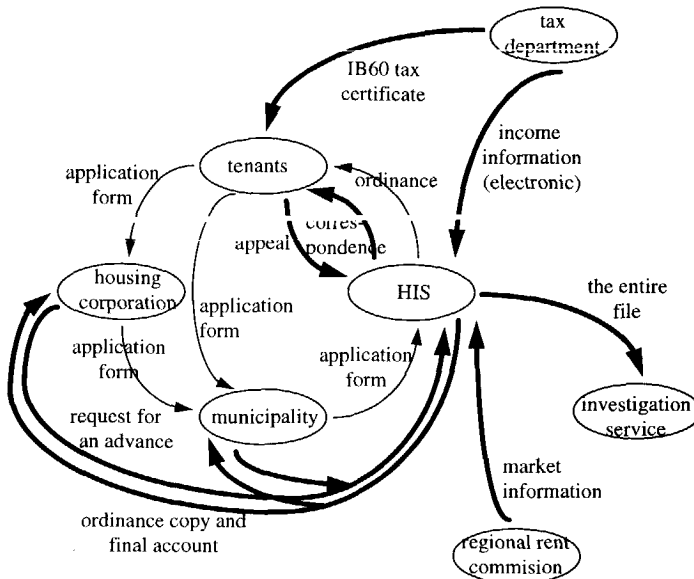


Figure 3.3 The organizational chain of the IRS program



### **3.2.2 Process structure and activity structure**

Each organization involved in the organizational chain has certain responsibilities, which are determined by law. Based on these responsibilities, each organization has a certain 'added value' to the organizational chain, for instance the intake of applications, supplying information to tenants, validation of supplied information, etc. In order to produce this added value, activities are performed by organizations.

The process structure and the activity structure of the housing corporations, municipalities and HIS, as described in section 2.2.1, are presented in this section. This presentation is confined to the primary organizational chain (see figure 3.1). For each organization within the primary chain, the processes are modeled. For convenience sake, 'housing corporations' or 'rental organization' is used instead of 'qualified rental organizations', because qualified rental organizations are often housing corporations.

#### **3.2.2.1 Housing corporation**

Regarding the IRS program within housing corporations, five processes are distinguished. These processes are more or less executed independently, with different frequencies.

##### *Process A. Processing continuations*

The so-called continuations are applications from tenants who already received IRS during the previous subsidy year. In April, pre-printed application forms are sent to the housing corporation. After the housing corporation has received these forms, an appointment is made with each tenant in order to fill in the application form. After filling in the form, it is forwarded to a municipality. The municipality checks the form with the population administration. Unless differences are established, the form is forwarded to HIS. Otherwise, it is returned to the housing corporation. Prior to the start of a new subsidy year, this process is executed for each tenant having received IRS.

##### *Process B. Processing new applications*

Throughout the subsidy year new applications for IRS can be submitted. Particularly, new applications are submitted when people move or have a major decrease of income (e.g. in case of a divorce). In case of a move, the qualifications for IRS are determined before the rental contract is drawn up. If someone is qualified, the rent moderation is implemented and the application form is forwarded to a municipality. If the maximal amount of subsidy is exceeded and there is no less expensive housing available, it is still possible to get IRS. In this case, however, the municipality has to approve.

Consequently, the application form is forwarded to the municipality for approval. After this approval, the rent moderation is implemented. This process is executed as often as new applications for IRS are submitted.

*Process C. Processing dispositions*

After forwarding an application to a municipality, the housing corporation effectuates the rent moderation. Hence, the rent moderation is implemented prior to the final decision of HIS. A copy of the disposition informs the housing corporation on the decision of HIS. The disposition is compared with the previously implemented rent moderation. In case of a deviation, the difference is recovered from the tenant and a new rent moderation is implemented. This process is executed for each disposition received by a housing corporation.

*Process D. Request for an advance*

Every month, housing corporations inform HIS regarding the rent to be moderated. Based on this information, HIS pays an advance. Accordingly, each month a specification of all tenants has to be drawn up showing the amounts of rent to be moderated.

*Process E. Processing final account*

During a subsidy year, housing corporations are paid advances based on the information supplied. At the end of a subsidy year, HIS determines the amount of subsidy which should have been paid to a housing corporation according to the administration of HIS. This amount is compared with the advances paid. Differences are to be explained by the housing corporation. This may result in an adjustment of rent moderation. Eventually, this has to be recovered from the tenant.

Figure 3.4 shows the structure of these processes. Each rectangle represents an activity with a clear beginning and ending. The arrows represent the sequence in which the activities are executed. The top of the figure shows the resources. The symbol  $\perp$  denotes the end of the process and activity. For each process, both the input and the output are shown. Figure 3.4 shows that process D, a request for an advance, does not have external input. This shows that a housing corporation will have to execute this process on its own initiative. It is in the interest of a housing corporation to receive advances from the Ministry. Consequently, it can be expected that housing corporations will execute this process on schedule.

Since this presentation is confined to the primary organizational chain, only the activities of the processes (A) implementing continuations, and (B) implementing new applications, are modeled (see appendix B.1).

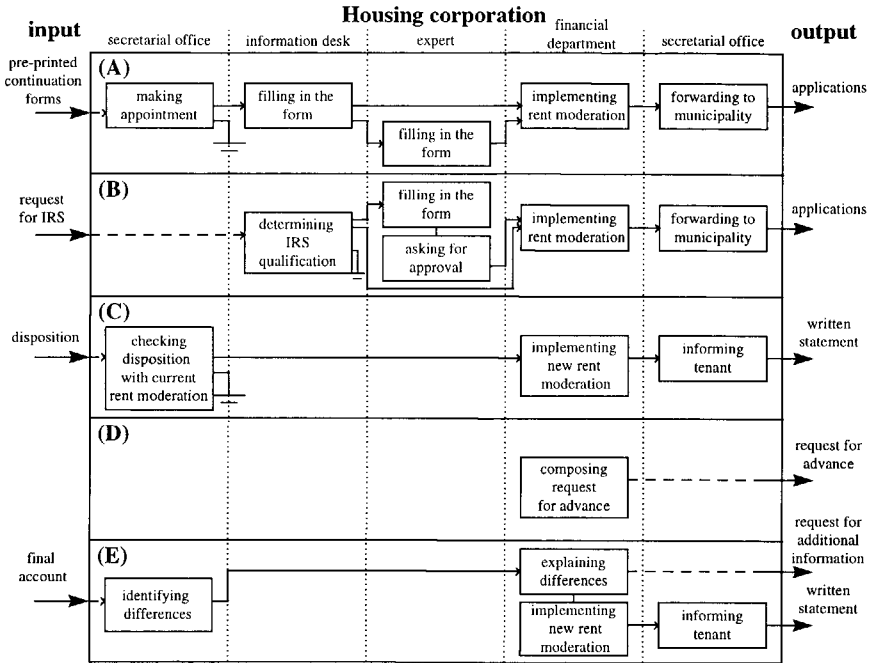


Figure 3.4 Process structure of housing corporations

Both, the process structure and the activity structure suggest that each housing corporation executes its processes similarly. This is, however, not valid. Given the fact that about 2,000 rental organizations are involved in the IRS program, differences are likely to occur. The following differences were found:

- Each rental organization can inform HIS regarding their preference in processing the continuation forms. Some rental organizations prefer to receive the continuations forms directly from HIS, others prefer the continuation forms to be sent to the tenants by HIS. In case forms are sent to tenants, some forms get lost or are forgotten at an appointment. If forms are sent directly to the tenants, one can apply for IRS by mail, thereby reducing the capacity needed to schedule appointments. Compared to rental organizations receiving the forms, those preferring the forms to be sent to tenants are less active toward tenants.
- Rental organizations and municipalities show different ways of co-operation. Sometimes, the municipality is handed over the forms by the

rental organization. Furthermore, the municipality checks them, and failing forms are returned to the rental organization. To recover the failures, the rental organization schedules an appointment with the tenant. In some cases, one form may be exchanged several times between a rental organization and a municipality. To solve this problem, some municipalities provide the rental organization with a print-out of the population administration. This enables rental organizations to perform the checks needed to be done by the municipality. One municipality and rental organization was found who solved this problem by electronic data exchange. The rental organization enters the data of the applications in a dedicated system and forwards it electronically to the municipality. The municipality checks the data automatically with the automated population administration and provides the rental organization with a print-out of the failures. The rental organization deals with the recovering failures which are checked by the municipality. Consequently, the municipality will only receive hard-copy applications which are already compared to the population administration. After some minor checks regarding the income and the calculated subsidy, these applications are forwarded to HIS.

### **3.2.2.2 Municipality**

As mentioned earlier, the role of municipalities in the IRS program is twofold. In case a municipality operates like a rental organization, its organizational processes are similar to those of a housing corporation. These processes are described in the previous section. This section presents the processes of municipalities in case they operate like a front office of HIS.

If a municipality operates like a HIS front office, it executes two processes:

- A. Check the applications which are accepted by rental organizations;
- B. Process applications which are submitted by tenants who rent a house from a non-participating rental organization.

In case applications are accepted by a rental organization, three checks need to be performed:

- comparing the composition of the household with the population administration;
- comparing the calculated subsidy with the maximal amount of subsidy and
- determining the appropriateness of the housing by comparing the amount of rent with the tenant's income.

A municipality has to motivate the reasons for accepting a subsidy exceeding the maximum. The structure of these processes is shown in figure 3.5.

Quite regularly, a tenant is not provided with written information. Because a municipality is a governmental organization, it is obligated to provide a written statement regarding the rejection. Hence, the rejection is a document which can be the output of the process.

The IRS program offers municipalities the possibility to pay tenants the subsidy in advance monthly. This service is offered to tenants who refuse to provide a housing corporation with income information, or rent a house of a non-participating rental organization. Some municipalities offer this service to tenants, whereas others do not, and refer to the quarterly payments of HIS. In case a municipality pays the subsidy in advance, the processes 'processing dispositions', 'request for an advance' and 'processing final account' become operational. These processes are similar to the processes of housing corporations. In case the monthly payment service is not offered, the activity 'implement subsidy' does not apply and the financial department is not involved in processing IRS applications. Each activity of figure 3.5 is modeled in appendix B.1.

Figure 3.5 shows that in case the municipality does not pay the subsidy to the tenant, except for the checks it performs, the municipality holds no added value to the IRS process.

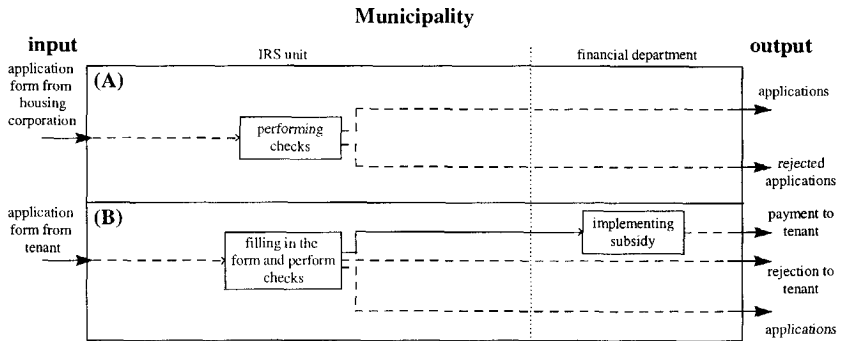


Figure 3.5 Process structure of municipalities

There are 633 municipalities in the Netherlands, which are autonomous regarding their organizational structure (section 159, local government act) [Brouwer-Koeijers and Ravelli 1994]. Consequently, regarding the execution of IRS processes, a number of differences between municipalities exist. The regulations of the IRS program are to be followed. The output of the process is determined by the IRS program, however not the way the municipality

implements the process. Besides the difference regarding the monthly payment, the following differences were found:

- The IRS program is very strict regarding the checks municipalities should perform on applications. Compared to applications submitted by tenants, applications which are accepted by participating rental organizations should be checked less intensively [VROM 1995]. Some municipalities, however, do not distinguish this difference, and intensively check each application. On the other hand, municipalities exist who use a less strict regime of checking. The way of checking is tuned to the characteristics of the tenants. For instance, a municipality with a large number of tenants occupying homes for the elderly, rarely checks the population administration.
- The number of tenants applying for IRS at the municipality is determined by the number of inhabitants and the number of private landlords. In case a municipality is confronted with a large number of tenants submitting their application to the municipality, the process of intake is similar to that of a housing corporation. In this case, appointments are scheduled with tenants, and a distinction is made between continuations and new applications.
- Finally, differences exist between municipalities regarding the exchange of documents with participating rental organizations. Assuming the perspective of the housing corporations, these differences are described in the previous section. In addition to these differences, a number of housing corporations exists which out-source their IRS activities to a municipality. In this case, the municipality executes all processes described in the previous section. At the beginning of a subsidy year, the housing corporation provides the municipality with a list containing the rent due by all tenants. Each month, the municipality provides the housing corporation with a print-out of the rent moderation.

### **3.2.2.3 HIS department**

While physically located in one office in the Hague, the HIS organization is regionally structured. It exists of five regional units, each containing four task groups named A, B, C and D. The task groups A are responsible for administrative support, such as data entering, sorting applications and checking completeness. The task groups B, C and D treat the actual applications. Within one unit, these task groups are interchangeable. For convenience sake, the following presentation only refers to task group B.

Within HIS, four processes are distinguished which are more or less executed independently with different frequencies.

*Process A. Processing applications*

On a process level, HIS does not distinguish continuations and new applications such as housing corporations. HIS makes a distinction between 'smooth' applications and 'non-smooth' applications. The decision for a smooth application is made automatically. Smooth applications are continuations where, compared with the previous subsidy year, no change of information occurred. Non-smooth applications are new applications or continuations containing changes.

Applications received by the Ministry are sorted regionally by its postal service. After sorting, the applications are handed over to task group A of the appropriate unit. Task group A sorts the applications by type (new and continuations) and by group (B, C or D). Afterwards, the applications are registered and the data are added to the system. Furthermore, the availability of required information is checked. In case information is missing, the application is returned to the municipality by mail. The smoothness of the applications is checked automatically. Non-smooth applications are forwarded to task group B. The system signals the reasons of an application being non-smooth. This determines the action taken by task group B. Possible courses of action are:

- checking the income information with the tax service;
- contacting a municipality regarding: (1) the composition of the household, (2) the calculated subsidy compared with the maximal subsidy, (3) the amount of rent compared with the previously calculated subsidy;
- checking the regional rent committee concerning the availability of less expensive housing and the fairness of the rent.

In case of a discrepancy between the information on the application form and information available at HIS or other services, the tenant is informed and required to substitute the information supplied. After correcting the differences, the formal decision is made automatically by HIS. Accordingly, the disposition is sent to the tenant. The municipality receives a copy of the disposition.

*Process B. Processing correspondence*

Each year, HIS processes about 169,000 letters concerning appeals and tenants' requests for additional information regarding a decision or reclamation of subsidy. Incoming and outgoing letters are registered by task group A, after which task group B deals with them.

*Process C. Paying advances*

Each month, housing corporations and municipalities are allowed to apply for an advance due to rent moderation. In order to apply for an advance, the

parties mentioned are obligated to specify the rent moderation. After checking this specification with the HIS administration, the advance is paid.

*Process D. Settling accounts*

At the end of the subsidy year, HIS formulates a final account regarding the advances paid throughout the subsidy year and the final decisions concerning applications. First, differences need to be resolved by rental organizations and municipalities, after which the tenants are required to do so.

Figure 3.6 shows a model of these processes. Since this presentation is confined to the primary organizational chain appendix B.1 only models the activities of the process (A) processing applications.

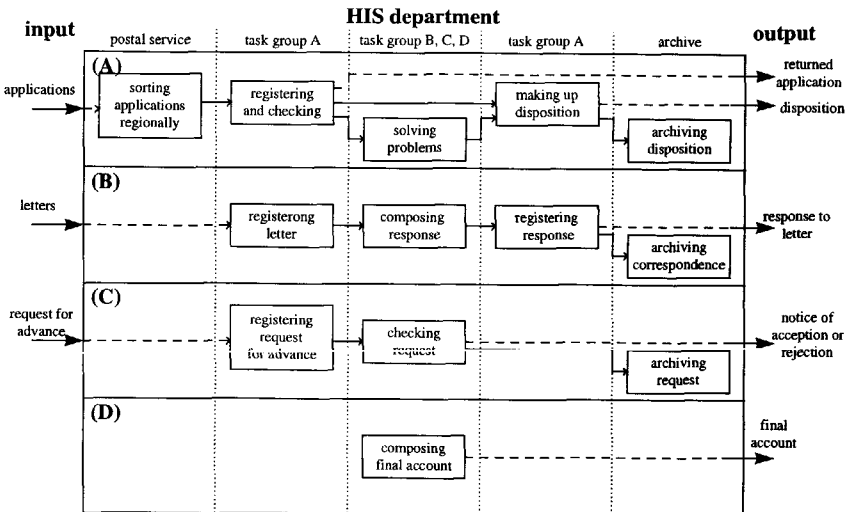


Figure 3.6 Process structure of HIS

Each task group contains 10 to 12 employees, including a group leader. Regarding the processing of applications, two differences between task groups were encountered. At the beginning of a new subsidy year, large amounts of continuations are submitted. Task groups set different priorities in processing these continuations. In a relatively short period of time, a large number of continuations has to be entered by task groups A. Some groups split up their capacity time-based (e.g. during the morning continuations and in the afternoon new applications), whereas others split up person-based (e.g. some group members process continuations, others new applications). Within groups B, a difference regarding work assignment occurs. Some



groups assign new cases to employees based on their expertise (e.g. assigning difficult cases to senior employees), while other groups assign work based on the number of cases in progress (e.g. an employee dealing with the lowest number of cases in progress is applied to new cases).

### **3.2.3 Predictability of the process**

The description of the IRS process in the previous section shows that organizations having similar responsibilities (e.g. housing corporations and municipalities) implement processes differently. These differences occur on the level of the organizational chain, the process and the activity. The different ways of co-operation between housing corporations and municipalities are variants in the organizational chain. Differences regarding the application of monthly payments by municipalities, however, are variants in the process, whereas differences in the task assignment are variants in the activity. These differences only exist due to the focusing on the entire IRS process, taking all organizations involved into account.

The differences encountered in the execution of the IRS program show a number of discrepancies regarding the co-operation between housing corporations and municipalities. It is difficult to incorporate these differences in one process model. The complexity of the process model is reduced by identifying different ways of co-operation [Uijlenbroek et.al. 1996, Mulder and Uijlenbroek 1997]. Four ways of co-operation are distinguished: a low level of co-operation, a high level of co-operation, a 'housing corporation-model' and a 'municipality-model'. These ways of co-operation are described below.

#### *Low level of co-operation*

Housing corporations and municipalities have organized their processes without regarding the co-operating organization. The exclusive arrangements are: the transfer of application forms between a housing corporation and a municipality. No arrangements are made concerning the checks performed and the manner in which the exceptions should be dealt with. Forms, failing to pass the checks performed by a municipality, are returned to the housing corporation with very little additional information regarding the reason of failure. Hence, in order to have a form corrected, a housing corporation is required to contact either the tenant or the municipality.

#### *High level of co-operation*

A variety of arrangements exists, regarding the transfer of documents, the checks performed by municipalities, and the manner in which exceptions should be dealt with. Municipalities supply a maximum amount of information

involving a tenant. This includes the highly confidential information regarding the population administration. The information is exchanged automatically prior to the exchange of the forms. After checking the information, the results are reported to the housing corporation. The forms forwarded to the municipality are those which have passed the checks performed by the housing corporation.

#### *Housing corporation-model*

Tasks of the municipality are delegated to the housing corporation. Hence, the involvement of the municipality in executing the IRS program is reduced to a minimum, including the checks of the population administration. For example, this situation exists in the municipality of Groningen. The municipality is merely involved in determining the policy, it therefore fulfills no operational tasks.

#### *Municipality-model*

This model is the counterpart of the housing corporation model, in which the housing corporation has delegated its tasks to the municipality. The municipality contacts tenants and deals with the intake of the forms. The housing corporation is merely involved in supplying rent information to the municipality and implementing rent moderation. The amount of rent to be moderated is determined by the municipality, whereas the housing corporation deals with requesting advances and processing final accounts.

#### *Conclusion regarding the predictability of the process*

The possibility is demonstrated in order to model the IRS program on the level of the organizational chain, the process and the activity. The models show the processing of applications throughout the organizational chain. Using these models, a number of different ways of co-ordination between housing corporations and municipalities are identified. Regarding these forms of co-ordination, it is concluded that processing applications contains a high level of predictability.

### **3.3 Document manipulation**

#### **3.3.1 Document exchange**

A large number of documents are exchanged between organizations and departments. The process structure shows documents exchanged between organizations as input or output. The process structure does not explicitly mention documents exchanged between departments. These can, however,

easily be derived from the activity structure. Figure 3.7 provides an overview of the documents exchanged. This overview is confined to the primary chain.

Figure 3.7 is in fact a document inventory [Popkin 1994] related to the organizational process. Besides presenting the usage of documents in processes, figure 3.7 also shows which departments create or destroy certain documents and between which organizations these documents are exchanged. Figure 3.7 is complementary to figure 3.1 (the primary organizational chain) and the process structures of section 3.2. It shows the importance of certain documents within an organization. For instance, the 'schedule of appointments', which is used within housing corporations. Some documents are processed by several departments within one organization. An example being the ability of each department of a housing corporation to process the pre-printed continuation forms. The latter is explained by process models in the previous section.

Organization	Process	Document	Originate(o)/ Destroy (d)	External exchange
<b>housing corporations</b>				
	<b>processing continuations</b>			
		pre-printed continuation form		from HIS
		request to make appointment	o: secr. off.	to tenant
		schedule of appointments	o: secr. off. d: info. desk	
		proposed rent moderation	o: info. desk o: expert	to tenant
		copy of evidential documents	o: info. desk	to municip.
		completed application form	o: info. desk	to municip.
	<b>processing new applications</b>			
		blank application form		from HIS
		request for permission to deviate	o: expert	to municip.
		written permission of municipality		from municip.
		proposed rent moderation	o: info. desk o: expert	to tenant
		copy of evidential documents	o: info. desk	to municip.
		completed application form	o: info. desk	to municip.

Figure 3.7 Document inventory

### 3.3.2 Document modification

The activity structure shows the activities performed on certain documents. The activity structure, however, does not explain the modifications of documents. Regarding each activity of housing corporations, figure 3.8 summarizes the dealings of a document. This figure is limited to the processes performed in the primary organizational chain. The modification of documents within municipalities and HIS is summarized in appendix B.2.

Process	Activity	Document	Modification
<b>processing continuations</b>			
	scheduling appointment	pre-printed continuation form	use information
		request to make appointment	compose
	filling in the form	copies of evidential information	collect
		completed application form	pre-printed continuation form with added information
		proposed rent moderation	compose
	implementing rent moderation	proposed rent moderation	use information
	forwarding to municipality	completed application form	record forwarding make copy
		copies of evidential information	make copy
<b>processing new applications</b>			
	determining IRS qualification	blank application form	add information
	filling in the form	copies of evidential information	collect
		completed application form	add information
		proposed rent moderation	compose
	asking for approval	copies of evidential information	make copy
		completed application form	make copy
		proposed rent moderation	make copy
		request for permission to deviate	record sending make copy
		written permission of municipality	record receiving
	implementing rent moderation	proposed rent moderation	use information
	forwarding to municipality	copies of evidential information	record forwarding make copy
		completed application form	make copy
		written permission of municipality	make copy

Figure 3.8 Document modification within housing corporations

### 3.3.3 Significance of documents

Section 1.2 describes the significance of documents from both the archival and the organizational perspective. This section describes the significance of documents in the IRS program.

#### *Mechanism for communication*

Documents are of great importance to the IRS program since they are the dominant mechanism for communication. Each application for an IRS subsidy is substantiated by an application form, either pre-printed or not. An application form is the dominant vehicle for business processes within organizations involved. The significance of documents from this point of view is visualized by identifying the document exchange between and within organizations.

#### *Internal and external accountability*

First, municipalities check the supplied household information with the population administration. Furthermore, the results are registered on the

application form after which it is forwarded to HIS. Copies of evidential documents are enclosed to substantiate the calculated subsidy. These kinds of activities are executed in order to substantiate external accountability. Due to internal accountability the 'proposed rent moderation' form, used by housing corporations, and the 'proposed rent subsidy' form, used by municipalities, are significant. The financial department requires these forms to substantiate the amount of rent moderated or paid.

#### *Organizational memory*

At the end of the subsidy year, a final settlement of accounts is formulated: the amount of subsidy paid or moderated is compared with the advances paid by HIS. Differences have to be explained. This can only be done on the condition of retrieving the information used to calculate the proposed subsidy. This appeals to documents as a means of organizational memory. It also illustrates that documents remain of significance after the initial process of creation.

#### *Public value*

Section 1.2 mentions that by informing people, documents are of value to the general public. Due to relating to individual cases, documents categorized in the previous section are of no importance to the general public. Examples of important documents are: documents describing the IRS program, the processing of applications and the necessary qualifications.

#### *Cultural and historical value*

With respect to the IRS program, neither cultural nor historical value of documents relates to individual cases. The execution of the program, the type of people applying it, and the quantity of fraud cases are examples of issues which might be of importance from a cultural and historical point of view. These issues, however, do not require the lasting availability of each case. Together with a representative collection of cases, information regarding the actual program will satisfy. Hence, the cultural and historical significance of documents described in the previous section, is relatively low.

### **3.3.4 Structure of information**

Most documents used in the IRS program, especially the application forms, are structured questionnaires with closed questions. Consequently, the information on these forms supplied by tenants is also structured. Some documents contain less structured information, for instance the motivation of rejection and the motivation of the request to deviate from the policy. These are examples of textual information embedded in a structured form. On the

form, the essence of this textual information is also represented in a structured way (e.g. by marking one or more of the possible grounds for rejection). Consequently, it can be concluded that the information used in the primary chain is well-structured.

### **3.4 IT support**

Housing corporations, municipalities and HIS all use information technology in order to support the IRS process. The software applications used are dedicated applications which do not integrate with other systems.

Housing corporations use IT to support the registration of tenants, to calculate the amount of subsidy and to compose a request for an advance. Originally, the software applications used by housing corporations are financial applications. In order to support the IRS, some additional functions are incorporated. These functions do not relate to the actual IRS process. One example being the impossibility to link a starting date with the rent to be moderated. Hence, as new rent levels are determined by the end of May, all rent moderations have to be added to the system by the end of June. Entering the rent moderation at the moment of determination, e.g. the beginning of May, is not possible.

Municipalities employ dedicated IRS software applications. These software applications are used to register applications and to (re)calculate the amount of subsidy. Sometimes, these software applications enable the user to automatically check personal details with the population administration. Usually, personal details are, however, checked manually. In case personal details are checked automatically, the output appears to be of poor quality. Due to typing errors in family names and addresses, which can be easily corrected, differences have to be checked manually.

HIS employs a software application with several process-related functions. Examples are the status of an IRS application relating to the process and the automatic assignment of IRS applications to one of the task groups B, after task group A has entered the data. In addition to the automatic check of applications, both the amount of subsidy is calculated and the disposition is drawn up automatically. Still, within HIS the majority of documents are exchanged on hard-copy. In case an application is assigned to a task group B, the paper file is also moved.

### 3.5 Simulating the IRS process of the HIS department

Until now, except for some remarks regarding the start of the subsidy year when HIS has to process a large number of continuations, only static aspects of the IRS process are described. This section studies the dynamics of the primary IRS chain by using a simulation model. The simulation model is limited to the HIS department.

Section 3.2.2.3 shows that task groups use different criteria for task assignment. Furthermore, at the start of a subsidy year, task groups use different priorities in processing applications. Building a simulation model requires a reduction of the complexity existing in the real world [Sol 1982]. In order to reduce complexities, such as the differences between task groups, the following assumptions can be made:

- It is assumed that no significant differences exist between the five regionally organized task groups. Given the fact that each region has the same number of employees, a similar workload for each region is expected.
- One member of group A supports four members of group B. In reality, one group A, containing 10 employees, supports three groups B, each containing 12 employees. Each group A and B has one group leader. This results in  $11/3$  employees of group B for each member of group A. Given the fact that during demanding periods the group leader also performs operational tasks, the simulation model shows that each member of task group A supports four members of the group B.
- At the beginning of a new subsidy year, newly received applications are kept in store. Groups A differ in dealing with stored applications. The simulation model shows that the number of applications taken out of store are limited to a maximum of 400 a day.
- After eight hours, applications processed by group A, are automatically handed over to group B. Actually, group B continues processing the next working day. By using a 24 hour delay, the transfer of applications from group A to group B is implemented in the simulation model.

Figure 3.9 shows the measured workload and output of HIS. The output of HIS is measured using the postal registration, which registers all incoming and outgoing correspondence. In week 37 a strong increase of the output occurred. During this week, the policy was set and the processing of applications in store was started. During the first few weeks after week 37, an high output occurred due to the high percentage of automatically processed applications.

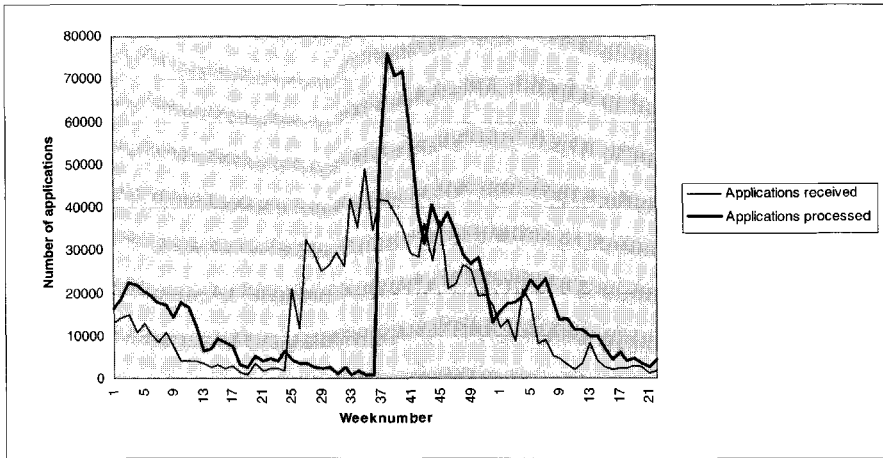


Figure 3.9 Measured workload and output from January 1994 to July 1995 per week

In order to stabilize the value of the model variables, a simulation model requires a start-up time. A variable is steady if its value is relatively constant or if it shows a steady increase. The average life span of applications is a sufficient variable for determining the start-up time. Figure 3.10 shows the average life span of three kinds of applications:

- continuations of previously granted subsidies without changes: these applications are processed automatically;
- continuations of previously granted subsidies with changes: these applications are processed by task group B;
- new applications: these are also processed by task group B.

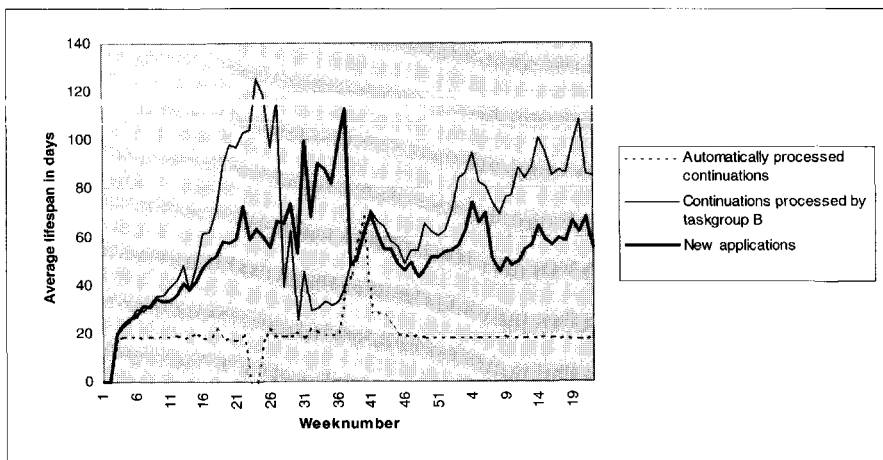


Figure 3.10 Average life span of applications in days processed from January 1994 to July 1995



Based on the longest cycle of the model, the run length of a treatment is determined. As a rule, three times the longest cycle (here approximately 125 days) is used. This results in a run length of 53 weeks. Figure 3.9 shows the year cycle of the IRS. This cycle is explained by the fixed subsidy year of the IRS: in order to receive continuation of granted subsidy, an applicant should ultimately apply in July. This results in a strong increase of the workload during the summer. Due to the increase of the run length to 63 weeks, a treatment starting at week 1 will include an entire subsidy year.

	Num. Of obs.	min. value	max. value	$\delta$	stnd. dev.	num. of repl. <sup>18</sup>
automatically processed continuations	10	19,91	34,91	5,00	5,19	23
continuations processed by task groups B	10	25,92	40,48	4,85	5,30	23
new applications	10	33,28	38,56	1,76	1,63	17

Figure 3.11 Initial experiments expressed in days

	num. of obs.	mean	standard deviation	95% confidence interval
automatically processed continuations	23	24,73	4,61	[22,23 - 27,23]
continuations processed by task groups B	23	29,71	4,50	[27,18 - 32,24]
new applications	23	46,55	1,29	[45,67 - 47,34]

Figure 3.12 Result of the 'as is' model

The number of replications required can be determined from the start-up time, the run length and the model output being clear. In order to determine the number of replications a desired risk  $\alpha$ , and the width of the  $(1-\alpha)$  confidence interval for the output variable are selected. In order to determine the number of replications, an initial experiment at a significance level with  $\alpha=0.05$  and  $N_0=10$  is performed. For the width of the  $(1-\alpha)$  confidence interval of the three kinds of applications,  $\frac{1}{3}$  of the difference between the minimum and the maximum value, found in the first 10 replications, was used. Figure 3.11 shows the result of the initial experiment. Based on this result with  $N_0=10$ , and an additional experiment of  $(23-10=)$  13, replications were performed. Figure 3.12 shows these results together with a 95% confidence interval.

Figure 3.13 shows the measured output and the model output. The model is validated by performing a chi-square test ( $\chi^2$ ) on these two data sets [e.g.

<sup>18</sup> Using  $t_{n-1,0,025} = 2,262$  and  $n' = n * (h/h')^2$  with  $n$  representing the number of replications and  $h$  the required confidence interval;  $h = \text{square root of } (S^2/n)$ .

Bots 1992]. The difference between the two data sets is calculated using:  $\sum(f_i - e_i)^2/e_i$  with  $f_i$  referring to the model output and  $e_i$  to the measured output. The calculated value for  $\chi^2$  is 29.83. The hypotheses for accepting the model output as representative for the measured output requires a value of  $\chi^2$  less than or equal to 79.1 ( $\alpha=0,05$  and  $v=66$ ). Since this is the case, the model is expected to be valid.

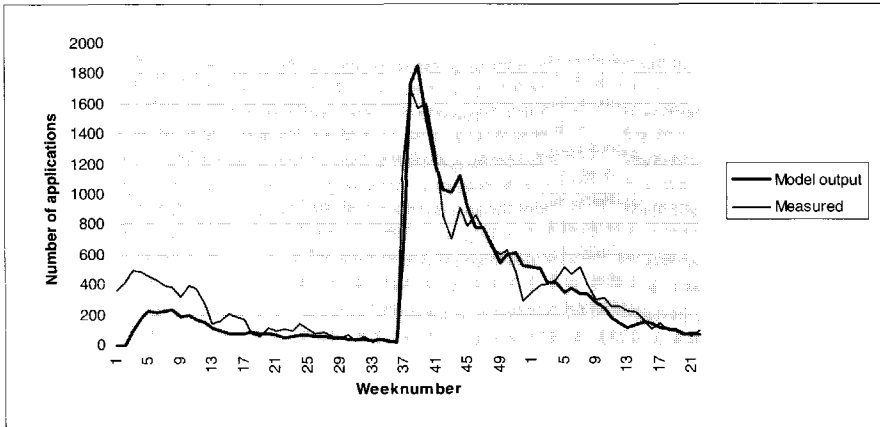


Figure 3.13 Output of processed application by one task group per week from January 1994 to July 1995

### 3.6 Problems and alternatives

#### 3.6.1 Problems with the implementation of the IRS program

The implementation of the IRS is confronted with a number of problems described below.

##### *Up-to-date information*

Organizations involved in the IRS program partly use the same information: personal details including information regarding addresses, income, and rent. The information supplied by a tenant is compared with the data concerning the tenant, which already in possession of the organization. This comparison may lead to different conclusions, since organizations involved use different sources to keep their information up to date.

Municipalities use the automated population administration to check the personal details. Citizens are obligated to report a change of address to their

new residence municipality within five days<sup>19</sup> (Dutch Population Administration Code) [Boon 1995]. Citizens, however, often report their new addresses some time after moving, whereas sometimes no report is filed. Consequently, the population administration is not up to date, while the address information of housing corporations, on the other hand, is. Since housing corporations decide on assigning a house to a tenant, they are the first to be informed regarding a move. People leaving a house owned by a housing corporation are eager to report this because of rent payments. Compared with municipalities and housing corporations, HIS has the most outdated information regarding addresses and personal details, for instance the number of people in a household. HIS can merely check personal details with the data of the previous subsidy year.

The tax department sets the final income, which determines the amount of IRS one can obtain. Consequently, up to date tax information is only available at the tax department. The income information supplied by tenants, has to be substantiated by a pay slip. Housing corporations and municipalities can merely check the information supplied with information of the previous subsidy year. In case a tenant has earned income from several employers, it is almost impossible to check the reporting of all income sources. HIS uses the income information of the tax department. The tax income year runs from January until December, while the subsidy year runs from July until June. The tax declaration is not executed until April, and the tax assessment not until November. Consequently, the tax department's income information is at least 11 months out of date.

Housing corporations hold the highest level of updated rent information. In May, new rent levels are determined by the housing corporations and announced to the tenants. In case of the intake of the application being performed by a housing corporation, hardly any deviations occur. In case of the intake being performed by a municipality, the reported rent has to be substantiated by a recently written statement of the rental organization. Since this check is executed at the start of the organizational chain, doubts about the supplied rent information are hardly present, except regarding the fairness of the rent and the availability of less expensive housing.

Organizations in the primary organizational chain may draw different conclusions regarding personal details, income information, or rent

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<sup>19</sup> Original in Dutch: 'De ingezetene die zijn adres wijzigt, is verplicht binnen vijf dagen na de wijziging van het adres bij het bestuur van de gemeente waar hij zijn nieuwe adres heeft, schriftelijk aangifte van adres wijziging te doen.' Wet GBA, art. 66 sub 1.

information. In this case, the application is traced back in order to correct the deviations. Furthermore, the disposition drawn up by HIS may deviate from the housing corporation's or the municipality's subsidy calculation. A deviation in the amount of subsidy requires an adjustment in retroaction of the rent moderation. In the first case, a municipality requests a housing corporation, and/or HIS requests a municipality to correct deviations or supply additional information (e.g. a statement concerning the living situation of a tenant). In the second case, the moderated rent or the subsidy paid by a municipality is corrected and differences are to be recovered from the tenant. In case the subsidy year is ended prior to the identification of differences, these are resolved with the final settlement made up by HIS.

Appendix B.3 provides an overview of the documents processed by HIS. About 60% of HIS capacity is needed to process about 169,000 letters. Appendix B.3 also shows which kind of letters are exchanged due to deviations in information. About 61% of the letters processed by HIS relate to the deviations presented above.

#### *Re-entering of data*

The data on the application form, supplied by tenants, are added to a computer system in triplicate. Housing corporations, municipalities and HIS enter the data into their own systems. Hardly any information is exchanged electronically. In case HIS could employ the data entered by the housing corporations, the workload for task groups A would be heavily reduced, enabling a reduction of the capacity of task groups A.

#### *The large amounts of continuations at the start of the subsidy year*

In the previous section, the dynamics of the IRS process were presented. Figure 3.9 shows the peak of applications received by HIS at the start of a subsidy year. Due to this peak, the throughput of applications is temporarily delayed. Hence, for this particular period, differences between pre-calculated subsidy used for rent moderation and the disposition of HIS, remain unnoticed. During that period, the amount of subsidy to be resolved increases. This consequently complicates the resolving procedures of housing corporations and municipalities.

### **3.6.2 Alternatives for the existing IRS program**

To overcome the problems presented in the previous section, a number of alternatives to the IRS process are drawn up. These alternatives are categorized using the different levels of analysis described by Sol [1984, 1991]. Sol distinguishes between 'why', 'what', 'how', and 'with what'. 'Why'

relates to the goals one has, whereas 'what' refers to the instruments used. 'How' concerns the process of organizational implementation, whereas 'with what' refers to technological means. These levels of analysis are applied to the IRS, and should be addressed simultaneously. Within the public sector, 'why' refers to the policy goals set by politicians. Based on these goals, 'what' refers to the instruments used. The IRS is clearly a subsidy-instrument. Examples of other instruments are legislation or supplying information [Hood 1991]. 'How' refers to the implementation of the instruments. At this level, attention is paid to the delimitation of tasks between the public and private organizations involved. 'With what' refers to the (technological) tools used to perform organizational tasks. At this level, attention is paid to handling information and documents. Figure 3.14 shows a few examples of these levels of analysis for the IRS.

level of analyses	application for the IRS	some examples
<b>why?</b>	What are the main goals of the IRS?	Keeping quality housing available to low-income households at affordable prices.
<b>what?</b>	What kinds of instruments are used?	A subsidy which is ascribed to an individual and not to a household or a house. The subsidy depends on the income of the individual, his or her living situation, and the rent to be paid. The subsidy has a fixed subsidy year.
<b>how?</b>	How are the instruments implemented?	Housing corporations and municipalities gather all information, the Ministry decides.
<b>with what?</b>	Which technological means are being used?	The use of dedicated IT-tools, without electronic document interchange.

Figure 3.14 Levels of analyses applied to the IRS

Using these levels of analysis, a number of alternatives were generated for the IRS process. Figure 3.15 shows these alternatives, which are described in more detail in appendix B.4. At the 'why' level, it is not possible to generate alternatives: the goals are politically set. Altering these goals requires a political discussion<sup>20</sup>. The choice of implementing a certain type of instrument in order to reach a certain goal, is a political decision. The use of the subsidy instrument requires a politically decided budget. Last year, a discussion took place in Dutch parliament involving the IRS budget [Volkskrant 1996]. The parliament pressed the government to reduce the planned budget cutting. This illustrates the importance the parliament assigns to the subsidy instrument. Within current goals, dropping the fixed subsidy year seems possible. This will reduce the high number of applications processed at the start of the subsidy year. Within the current

<sup>20</sup> This marks an important difference with BPR processes: organizational goals may change as a result of a BPR process [Davenport 1993]. In the public sector organizational goals change as a result of political decision making. In terms of BPR, this implies that the political level should be involved in a BPR process for the IRS program.

political setting, several other alternatives exist at the 'how' and the 'with what' level. As a result of viewing the current organizational setting as a fact, most alternatives are expected to lead to limited improvements of the process.

Some alternatives, however, appear to require a change of law. These alternatives, nevertheless, refer to implementation aspects. For instance, the tax law needs to be changed in order to exchange information electronically between the tax department, the municipalities and the housing corporations. Furthermore, the law for the population administration needs to be altered in order to grant the Ministry and the housing corporations access to the GBA system.

The simulation model, presented in section 3.5, is used to study the effects of pre-processing applications by HIS before the final policy is set, thereby reducing the number of stored applications. This alternative is based on the assumption that applications which needed to be handled under the old policy by a task group B, will also need to be handled by task group B after the new policy is set. This means that in order to process an application (e.g. by contacting the regional rent committee or a municipality) during the period the new policy is not set yet, task group B can start obtaining the required (additional) information.

level of analyses	alternatives
why?	-
what?	<ul style="list-style-type: none"> <li>• Stop the existence of a fixed subsidy year</li> </ul>
how?	<ul style="list-style-type: none"> <li>• Allowing the housing corporations and the Ministry direct access to the GBA</li> <li>• Adding an IRS indication to the GBA</li> <li>• Allowing the housing corporations and the municipalities direct access to the system of the tax-department</li> <li>• Allowing the housing corporations and the municipalities with information regarding the number of income sources or applicants</li> <li>• Providing the housing corporations and the municipalities direct access to the HIS-system</li> <li>• Decentralizing the IRS operations to the municipalities or the housing corporations</li> <li>• Prolonging the subsidy in case there are no changes of information reported</li> </ul>
with what?	<ul style="list-style-type: none"> <li>• Sending a copy of the change of address to the housing corporations and the municipalities</li> <li>• Informing the housing corporations and the municipalities regarding established differences in supplied information</li> <li>• Using EDI between the housing corporations and the municipalities</li> <li>• Using EDI between the housing corporations and the municipalities, and the Ministry</li> <li>• Preprocessing applications by the Ministry before the final policy is set, thereby reducing the number of applications in store.</li> </ul>

Figure 3.15 Alternatives for the IRS process [in more detail described in appendix B.4]

Three experiments were performed with the simulation model [Uijlenbroek and Sol 1995, 1997]. Experiment 1 relates to the situation in which at the start of a subsidy year, the first of July, the policy is set for the coming year. This means that from the first of July, applications will immediately be processed, and that applications will not be stored. Experiment 2 relates to the pre-processing of applications from the first of July until the policy is set. Figure 3.16 shows the effects on the throughput. Even a small improvement of the throughput for the 'automatically processed continuations' worsens that of other applications. This is explained by the relatively high portion of applications processed automatically: 61%. Only 8% of the applications are continuations processed by task group B. About 31% of the applications received, derive from new applicants. Based on the results shown in figure 3.16 it is concluded that pre-processing applications hardly improves the throughput at HIS.

	Automatically processed continuations	Continuations processed by task groups B	New applications
'as is' model	3,5	4,2	6,6
experiment 1	2,7	6,6	6,6
experiment 2	3,4	7,1	8,8
experiment 3	1,9	3,2	3,8

Figure 3.16 Average throughput in weeks from January 1994 until June 1995

A third experiment is conducted without a fixed subsidy year. After receiving applications, and in case of available capacity, these are immediately processed. Figure 3.16 also shows the results of this experiment. It shows that dropping the fixed subsidy year strongly improves the throughput of applications. For this experiment, the bulk of applications starting in June is eliminated, and substituted by a steady input of applications which add up to the same number of continuations throughout the year.

### 3.7 Discussion

In order to study the use of documents in the execution of the IRS program, this chapter takes its organizational process as a starting point. It shows that the primary organizational chain, the processes within involved organizations, and the activities are well-structured. The information used is also well-structured and enables the prediction of document use, allowing an exhaustive enumeration of the documents used in the IRS program. Each of these documents is a hard-copy.

Section 1.2 summarizes the significance of documents from both the archival and the organizational perspective. Section 3.3.3 identifies the significance of documents with respect to the IRS program. It shows the simultaneous

existence of the significance of documents from both the archival and the organization perspective. Furthermore, it shows that the different aspects of the significance of documents can be determined on a process level. Consequently, it is concluded that an exhaustive enumeration of documents enables the identification of its significance on a process level.

The greater part of documents processed by HIS finds its origin in deviations between data of organizations involved. The elimination of differences in the data, makes these documents redundant. This requires a restructuring of the actual processes, including the responsibilities of organizations involved. This illustrates that an organizational process and its output determine the use of documents and their informational content, as argued in section 1.2. Consequently, it is concluded that besides focusing on documents, one should also focus on the organizational process which explains why documents exist. This implies that, without taking the process into account, document-based process improvement leads to a less optimal process design. Alternatively, when one does take the process into account an optimal process would be reached.

Currently, most documents used to execute the IRS program only exist on hard-copy. These documents are exchanged and manipulated on hard-copy. Some information is added to a computer system by housing corporations, municipalities, or HIS. This information is added to a structured database, which is part of a dedicated application. Electronically, only one type of information is used in the IRS process: structured information in a database. Currently, with respect to the IRS, EDM (see section 1.1.2) as an approach to handle different types of information, which are recorded, manipulated and managed electronically, is not an issue. It will, however, become a major issue when documents are going to be scanned by housing corporations and municipalities and electronically forwarded to HIS. The efficiency of such a process design should nevertheless be questioned. Some of the alternatives presented in section 3.6.2, e.g. decentralizing the IRS operation to municipalities, entirely eliminate the exchange of documents with HIS.

Section 3.2 shows that both housing corporations and municipalities implement the IRS process differently. These differences complicate system design at the level of the organizational chain. It is argued that system design should take the organizational process as a starting point, thereby trying to eliminate document exchange. This is executed by changing organizational responsibilities, rather than trying to improve document exchange by means of information and communication technology. In case document exchange



in the organizational chain is reduced to a minimum, EDM will be limited to one organization.

The IRS-process is application-driven: new processes start with the application submitted by a tenant. Currently, although applications are hard-copies, these can be transformed to an electronic document by scanning. The implementation of the IRS-process is well-structured. In case applications are transformed to electronic documents, it is possible to use work flow management tools in order to process these applications, without dispersion of hard-copies. Both the structure of the process and the information enable the use of dedicated supporting tools, which is especially welcome because of the high volume of the process. Using general tools which are not highly tuned to the IRS process, will be less optimal. Consequently, it is concluded that organizational processes with a structure and a volume like the IRS process should not be part of the range of processes which can be supported by an electronic document infrastructure.



## 4. Case 2: Semi-structured document usage: the Investigation Service

The Investigation Service is a department of the Ministry of Housing, Spatial Planning and the Environment. The main responsibility of the Investigation Service is investigating alleged fraud in the area the Ministry is responsible for.

This case study was conducted in 1994-'95. The object of this research was the use of documents within the Investigation Service. Hence, contrary to the IRS case described in the previous chapter, this case is not limited to a certain organizational process, but to an organizational unit: the Investigation Service which executes a number of related processes. This case study is described in [De Jong 1995, Uijlenbroek and Van der Meer 1996]. The instruments used to collect data are described in appendix A.2.

### 4.1 Investigation Service: mission and organization

The mission statement of the Investigation Service, derived from the responsibilities of the Ministry, is to 'maintain a high-quality and professional detective force to enforce laws and rules drawn up by the Ministry throughout the country'<sup>21</sup> [DRZ 1995]. In order to implement this mission statement, and to contribute to the social task of the Ministry, the Investigation Service strives for a close co-operation with other investigation services. Furthermore, it has a clear investigation policy which ensures the service to operate as a unity, and tries to generate support and co-operation for its investigations within other departments of the Ministry [DRZ 1994].

The Investigation Service operates independent of the Ministry while giving account of its actions directly to the minister and the management of the Ministry. The powers to investigate are limited to the Ministry's area. The primary tasks of the Investigation Service are:

- combating and discouraging abuse of subsidy programs and other regulations of the Ministry;
- conducting audits and investigations in order to either take civil or administrative actions, or to prosecute;
- conducting research in order to contribute to policy design.

These tasks are executed with respect to the ten areas the Ministry is responsible for. Figure 4.1 shows these areas and the capacity of the

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<sup>21</sup> In Dutch: 'Een kwalitatief hoogwaardige en professionele opsporingsdienst op de beleidsterreinen van VROM in het belang van de bestuurlijke en strafrechtelijke handhaving van de VROM wet- en regelgeving d.m.v. feitenonderzoek, met een landelijke dekking van haar activiteiten' [DRZ werkplan, 1995].

Investigation Service which is employed to these areas. It also shows the number of investigations conducted during 1994, the number of summons issued and the amount of fraud.

Area	Number of jobs in full-time equivalent	Number of investigations conducted	Number of summons issued	Amount of fraud in Dutch guilders
Housing regulations	4	42	12	100,815
Individual rent subsidy	20	716	121	625,119
Qualified organizations	2	2	0	2,778,574
Town and country planning	1,5	1	0	0
Environmental inspection	5	53	0	0
Personnel matters of the Ministry	1	5	0	1,011,500
Civil action	6	21	2	339,230
Administrative action	1,5	24	0	1,860,000
General research	3	2	0	not applicable
Policy development	1	1	1	not applicable
Total	45	867	136	6,715,238

Figure 4.1 Employment of the Investigation Service capacity by the end of 1994

### Organizational structure

Figure 4.2 shows the organizational structure of the Investigation Service. The management of the Investigation Service reports to the secretary-general and the minister. At the operational level the Investigation Service is regionally organized. Currently, the service has 45 employees (full-time equivalent). The Investigation Service has offices at the location of the Ministry in The Hague. The regional offices are distributed throughout the country. The supporting staff is located in The Hague.

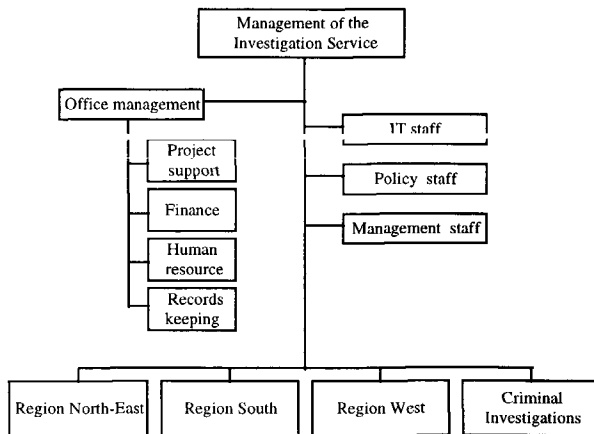


Figure 4.2 Organizational chart of the Investigation Service

*Problems encountered by the management*

The Investigation Service has grown rapidly, from 33 employees at the start of 1994, to 74 employees by the end of 1996. Expectations for 1995 indicate 1,731 investigations, while in 1994 only 867 investigations were conducted. This is the result of the high priority given to the suppression of fraud, leading to an increasing number of cases handed over to the Investigation Service.

The management of the Investigation Service is confronted with a number of document related problems [Nijman 1994, De Jong 1995]:

- Management suffers a shortage of information regarding the status of the workload and the output of the organization. This complicates setting priorities and scheduling new cases.
- The throughput of a relatively large part of cases is too high. IRS cases, which use about 50% of the capacity of the Investigation Service, should be finished within three months. About 85% of these cases are not completed within this amount of time.
- Currently, most information exists on hard-copy, requiring physical space for storage. About 75% of the space is already in use, while the Investigation Service is confronted with an increasing number of cases.

During an investigation, documents are created, exchanged and updated, both electronically and on hard-copy. After closing an investigation, these documents are handed over to the records keeping unit. Occasionally, a case is re-opened and documents are needed from the archive. The supporting staff is not able to maintain an appropriate level of services due to the fast organizational growth. The management of the Investigation Service considers IT a tool for solving the problems mentioned above. IT is especially considered with respect to the control of work flows.

In the following sections, the investigation process will be presented. The presentation focuses on the investigation of Individual Rent Subsidy fraud, because this kind of investigation needs almost 50% of the Investigation Service's capacity (see figure 4.1). The next section describes the investigation process according to section 2.3, distinguishing between the organizational chain, process, activity, and document manipulation. The design of supporting IT tools needed to provide the management with a better insight into the workload, is presented in section 4.3.

## 4.2 The investigation process and document manipulation

### 4.2.1 Interorganizational co-operation

During the process of investigating alleged fraud, investigators have a broad range of information sources: the tax department, local authorities including social security inspectors, housing corporations, the police, the criminal investigation service, tax inspectors of the inland revenue, the industrial insurance administration office, the Ministry of Justice, etc. Sometimes, investigators receive their information from other organizations strictly based on official procedures, whereas in some cases information is provided off the record. With some organizations, an agreement regarding the supply of information exists. These agreements differ in status from an official and signed contract to an informal working agreement.

Figure 4.3 shows the Investigation Service's incoming and outgoing information. Three types of information are exchanged with other organizations: (a) reports of alleged fraud, (b) research information and (c) conclusions of an investigation. Figure 4.4, 4.5 and 4.6 show which organizations are involved in this information exchange, the characteristics of the information exchanged, and the way these organizations cooperate with the Investigation Service.

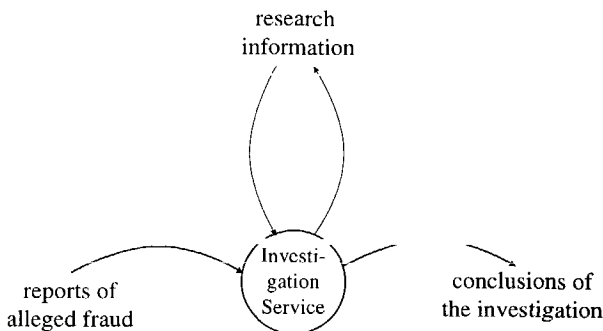


Figure 4.3 Incoming and outgoing information

Local authorities report the highest number of alleged fraud [De Jong 1995, p.66]. Reports of local authorities are often the result of investigations conducted by a social security inspector. These kinds of reports are often accompanied with a file containing background information, and copies of evidential documents. Reports from other organizations lack evidential documents, requiring a higher effort of the Investigation Service to acquire information. Except for those provided by HIS, reports are regionally received

and processed by the Investigation Service. Reports from HIS are received centrally and are only partly processed regionally. They are accompanied by a memorandum containing background information concerning alleged fraud. Both HIS and social security inspectors report alleged fraud in large amounts.

organization	way of reporting	way of co-operation
Social security inspectors	floppy, form, letter	mutual agreement
HIS department <sup>22</sup>	memorandum	contract
Anonymous information	letter, by phone	not applicable
Tax department	letter	mutual agreement
Local authorities	letter	no agreement/ad-hoc
The police	letter	'Plukze regeling' <sup>23</sup>
Housing corporations	letter	no agreement/ad-hoc

Figure 4.4 Reporting organizations of alleged fraud

During an investigation, a lot of information is exchanged between several organizations, employing all possible information carriers, digital and analogue. The information exchange between HIS and the Ministry of Justice is centrally organized. The information exchange with other organizations, shown in figures 4.5 and 4.6, occurs regionally. Figure 4.5 shows the 'formal' relations with information supplying organizations. Besides these formal relations, investigators also maintain their own informal contacts. These informal contacts generate 'off the record' information, which may be of great importance to an investigation. This kind of information is always formalized by means of written statements in case it is used as evidential information in an investigation. Informal information may result in pieces of scrap paper in the file.

organization	way of co-operation
HIS department	contract
Tax department	by law
Criminal Investigation Service	mutual agreement or covenant
Tax Investigation Service (in Dutch FIOD)	contract
Industrial Insurance Administration Office (in Dutch GAK)	informal
Local authorities	mutual agreement
Ministry of Justice	by law
Utility companies	informal
The public prosecutor	mutual agreement or covenant
The police	mutual agreement
Social security inspectors	mutual agreement
Housing corporations	mutual agreement

Figure 4.5 Way of co-operation with organizations to acquire research information

<sup>22</sup> This department is responsible for the execution of the Individual Rent Subsidy program (see also chapter 3).

<sup>23</sup> A policy to deprive criminals from their criminal profits.

An investigation may result in the following output:

- a final report of the investigation, also sent to the organization which reported the fraud;
- a summon issued, of which a copy is sent to the public prosecutor and the reporting organizations, and sometimes to the police or the Criminal Investigation Service.

In case no fraud has occurred, the reporting organization is informed by a report regarding the investigation.

Organization	way of co-operation
HIS department	contract
Criminal Investigation Service	mutual agreement or covenant
The public prosecutor	mutual agreement or covenant
The police	mutual agreement
Social security inspectors	mutual agreement

Figure 4.6 Ways of co-operation with organizations to report the result of an investigation

Figures 4.4 to 4.6 show that different ways of co-operation exist between the Investigation Service and other organizations. If the co-operation is based on a contract or a covenant, agreements are made regarding the way information is exchanged, the throughput time of the investigation, and the way certain cases should be dealt with.

#### 4.2.2 Process and activity structure

Reports of alleged fraud are input to the investigation process. The previous section showed which organizations report alleged fraud. Reports can be sent directly to the central office of the Investigation Service in The Hague. Investigators, who are located regionally, often bring new reports of alleged fraud when visiting an organization. These reports are mailed to the secretarial office for registration and preliminary examination.

Report are copied and registered by the secretarial office in a postal system named PRS. The original report is archived by the records keeping unit. In case the report relates to somebody known to the Investigation Service, the existing file is retrieved, otherwise a new file is created. The secretarial office checks the reports for lack of information (e.g. names and addresses of persons involved, day of birth, personal identification number, etc.). In case information is missing, the secretarial office contacts the reporting organization or, in case of an anonymous report, an investigator is contacted in order to collect the missing data. The preliminary examination is conducted by the secretarial office. The aim is to gather information regarding the report available at the Ministry. The result of the preliminary



examination is used to substantiate the decision to either start an investigation or dismiss the case.

An inspector, who is also often the head of a region, assigns cases to investigators. He or she may also decide to drop a case. Cases assigned to investigators are registered in a system named RIS95. By mail, the files are sent to an investigator in the region. The investigator draws up an 'investigation plan', which describes the methods to be used, the aim of the investigation, the expected throughput time, and the capacity required. Within one research area, these plans are quite similar.

Investigators can employ several tools in order to collect evidence regarding alleged fraud: written information is requested from organizations involved, locations are visited, and witnesses are questioned. These tools always result in a written document: investigators draw up reports of their findings and witnesses sign their statements. These documents are added to the file. The investigator is responsible for updating the investigation plan. If required, additional research tools can be applied. A report containing the findings of the investigation is drawn up. This report can have one of the following conclusions:

- fraud has occurred and the report contains the matching evidence;
- no fraud has occurred;
- there is not enough evidence to prove the fraud, whereas the suspicion remains.

The final report is checked by the inspector who decides the action to be taken: dismissing, handing over the case to the public prosecutor (e.g. issue a summon) or imposing a fine. Finally, the organization which reported the alleged fraud is informed regarding the outcome of the investigation and the file is archived by the records keeping unit. Figure 4.7 shows the process structure of the investigation process.

Some activities shown in the process structure are well-structured, whereas others are ill-structured, the latter being:

- preliminary examination;
- case assignment;
- investigation;
- drawing up the report;
- checking the report.

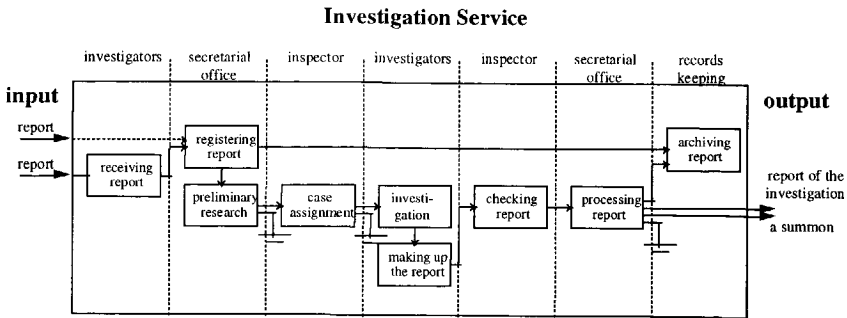


Figure 4.7 Process structure of an investigation

These ill-structured activities are goal-oriented [Sprague 1993]. Although the output of the activity is defined, the definition of the process is lacking. Nevertheless, instructions regarding the execution of these ill-structured activities exist, the 'investigation plan' for example, should be drawn up prior to the start of the investigation and be updated during the investigation. These kinds of instructions are not detailed and rely on the ability of individuals to make their own decisions. To ensure correct decisions, controls like checking the reports by an inspector, are added to the process.

The activities 'receiving report', 'registering report', 'processing report', and 'archiving report' are well-structured. Figure 4.8 summarizes the tasks of these activities. These are modeled using a task structure in [De Jong 1995 pg.55]. Clear instructions regarding each of these activities exist, relating to both the process and the output.

Activity	Tasks
Receiving report	Accepting report and forwarding it to the central office in The Hague for registering
Registering report	Registering report in postal system Making copy Checking the existence of a file Making a new file if necessary Forwarding original to the records keeping unit Checking the availability of personal information (name, address, etc.) Contacting reporting organization in case some information is missing
Processing report	Registering the conclusions of the final report Closing the case Checking the file for missing evidential documents Drawing up a layout of the final document Sending the final report according its conclusion Forwarding the file to the records keeping unit
Archiving report	Adding information to the file in order to make it accessible Registering the file Archiving the file

Figure 4.8 Well-structured activities and their tasks

### 4.2.3 Document manipulation

#### *Document exchange*

The Investigation Service is regionally organized. Figure 4.9 provides an overview of documents exchanged between the central office in The Hague and the regions. The letters in figure 4.9 denote the category of documents shown in figure 4.10. It shows that although a number of media are used for information exchange, paper documents are still of great importance to the investigation process.

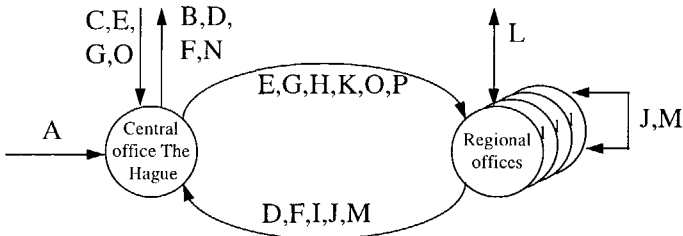


Figure 4.9. Information flows between the central office and the regional offices [electronic and hard-copy]

#### *Document modification*

Documents from other organizations received by the Investigation Service are always hard-copies. These documents are registered and identification marks are added to the document. For instance, a number generated by the postal system PRS is written on the document. Whereas a large number of documents is electronically composed by the investigators (e.g. reports of visits, using a word-processor), the exchange occurs on hard-copy.

In case the sequence of decisions and tasks (according to figure 2.1) regarding an activity is difficult to predict (e.g. the activity is ill-structured), document exchange and document modification are also difficult to predict. Consequently, it is not possible to model the modification of documents used in an investigation.

#### *Significance of documents*

The aim of an investigation is to gather evidence which substantiates fraud, thereby enabling legal action. The documents used are of great importance to proving fraud. The significance of documents remains high until neither further legal action nor further appeal is possible. The importance of documents is not limited to those that actually prove fraud. Additionally, documents which substantiate the carefulness of the investigation, enabling

the reconstruction of the investigation process, are of great importance. When taking a case to court, the gathering of evidence appears important.

Type of documents	Activity	Type of carrier	Exchange medium	Frequency of updates	Volume/year
A new cases A1. Letters, reports A2. Memos A3. Listings	registering new cases	paper paper, e-mail diskette	paper mail paper mail/local area network, paper mail, direct hand over	low high high	600 pages <sup>24</sup> unknown 0.5 - 1 MB per file
B results checks IRS dep.	preliminary examination	electronic file	local area network	high	0.5 - 1 MB per file
C explanations checks IRS dep.	preliminary examination	electronic file	local area network	high	1 - 3 MB per file
D request for additional IRS information	preliminary examination, investigation	e-mail, paper, spoken word	local area network, paper mail, telephone, meetings	low	unknown
E additional IRS information	preliminary examination, investigation	paper spoken word	paper mail, telephone, meetings	low	20,000 pages
F outgoing letters	preliminary examination, investigation	e-mail	local area network	low	2,150 pages
G incoming letters	preliminary examination, investigation	paper	paper mail	low	1,450 pages
H review information	preliminary examination	paper	paper mail	high	29,000 pages
I cases to write off	preliminary examination	paper	paper mail	low	600 pages
J ascribe a case to an investigator	preliminary examination	e-mail	local area network	low	670 pages
K case related information	investigation	paper diskette	paper mail	high	670 pages and 670 floppies
L information based on examinations	preliminary examination, investigation	paper	paper mail direct hand over	low	unknown
M research file	investigation	paper diskette	paper mail direct hand over	low	47,000 pages
N research conclusions (which is a part of M)	investigation	paper	paper mail	low	42,000 pages
O final report	making up the report	paper	paper mail	low	715 pages
P additional information	all activities	paper	paper mail direct hand over	low	7,500 pages

Figure 4.10 Characteristics of documents used in the investigation process

This shows that the external accountability (e.g. eventually in court) reaches beyond the other categories regarding the significance of documents, as described in section 1.2. Notwithstanding the fact that other categories, such as 'vehicle for business processes' and 'internal accountability' are equally important.

<sup>24</sup>The amount of pages in the archive with respect to the mentioned information flow.

### *Structure of information*

The information used by the Investigation Service is ill-structured. Figure 4.10 showed that the majority of the documents are letters, e-mails and sometimes even oral expressions. These documents contain unstructured information. During the investigation process, some information is structured and registered in structured databases (e.g. identification, name, conclusions of the investigation, etc.).

### **4.2.4 IT support**

Each employee of the Investigation Service uses a personal computer (PC). Investigators use portable PC's, allowing them to work on different locations. These portables have built-in modems, allowing the use of e-mail and file-transfer. Presently, files are exclusively transferred up to 25 Kb. Larger files are exchanged by using flexible disks. The regional offices only offer print facilities to investigators. The central office in The Hague is connected to the Ministry's IT-infrastructure.

The Investigation Service employs three types of applications: dedicated systems for registering documents and cases, regular PC-applications such as word-processors and spreadsheets, and a number of basic facilities supplied by the IT department of the Ministry: e-mail, telephone directory, zip-code database, etc.

The following dedicated systems are used:

- Postal system (PRS)  
Using this system, incoming and outgoing mail is registered. It contains functions for checking progress and registering document routing.
- Investigation information system (RIS95)  
This system is used to monitor cases. Besides reports of new cases, the actions taken during and the conclusions of the investigation are registered in this system, which is employed by the central office.
- Investigation support system  
Investigators use this system in order to register the progress of investigations. It offers functions to edit investigation plans and to generate pre-defined letters which can be edited by a word-processor.
- IRS system  
This system is of importance only to Individual Rent Subsidy-cases. It enables the registering of IRS-cases, making use of the information of the HIS-department, and processing the bulk of HIS-reports.

### **4.3 Designing electronic document management**

The previous sections describe the investigation process and document use. This section presents the design of EDM. Starting point for this design are document-based problems encountered by the management of the Investigation Service. Preceding the explanation of the design, these problems are presented.

#### **4.3.1 Document related problems**

Section 4.1 summarizes a number of document related problems encountered by the management of the Investigation Service. This section reformulates these problems, using the description of the previous section.

##### *Shortage of management information*

The Investigation Service uses dedicated applications to register incoming and outgoing letters, and the status of investigations. The management information generated by these applications does not fulfill the management's needs. The information is too detailed and it is not close-fitted to management issues such as setting priorities and scheduling capacity. Due to the ill-registering of documents, the output is not always accurate, and the status of investigations is unknown.

Presently, document registration is rather traditionally organized within the Investigation Service. Documents are received by mail, registered and classified and then forwarded for processing. The employees responsible for the registration of documents are not responsible for the processing. Furthermore, these employees only have limited knowledge of the document's topics and its processing. This explains why in some cases documents are poorly registered. In case information which should be registered is missing, the secretarial office contacts investigators who should collect the missing data. This consumes time, as a result of which the registration lags behind.

The status of documents should be registered by those responsible for its processing. This registration, however, rarely occurs. Registering documents is not regarded as a part of their primary tasks, as a result of which it is assigned a rather low priority. In case documents are personally handed over to employees in the regions, they are often not registered at all.

These problems emerge due to the growth of the organization. The management of the Investigation Service is used to be closely involved in operational tasks. This involvement provided them with insight into the

workload. The growth of the organization results in a larger span of control, which makes it impossible to be involved at an operational level. Consequently, the management has access to less direct information regarding on-going cases, and has to rely on management information generated by the PRS and RIS95 systems.

#### *Throughput of cases*

Concerning the control of work progress, the lack of management information accumulates. This is the result of the impossibility to determine in advance which cases will pass terms and to adjust the priority of these cases. About 42.5% (50% of 85%) of all cases processed by the Investigation Service passes terms (see also section 4.1).

#### *Physical space to store information*

From a documental point of view, the output of the investigation process is a file. Quite often, these files either contain redundant information or information also available electronically. Currently, about 75% of the physical space to store files is used, whereas the number of cases is expected to increase. Omission of redundant information from the file will only free 5 to 10% of the space currently used [De Jong 1995].

### **4.3.2 A design for electronic document management**

#### **4.3.2.1 Design issues**

##### *Integration of document management and process control*

Document management and process control are separately implemented in the Investigation Service. This separation exists both organizationally and technologically. The secretarial office registers documents and cases, whereas the investigators register the progress of the investigation. The PRS and RIS95 applications are not integrated. Furthermore, it is impossible to link electronic documents to these applications.

Document management is limited to paper documents. Electronic documents are not managed, which explains why the records keeping unit only files paper documents and pays no attention to the electronic equivalents available within the Investigation Service.

Contemporary, IT enables the integration of document management and process control, both organizationally and electronically. A large number of tools supporting document management, process control or both, are available on the market (see section 2.2.3). These tools take electronic

documents as a starting point. Hence, applying these tools needs the transformation from paper to electronic documents used in the investigation process.

*Electronic document processing*

Figure 4.11 shows the basic structure of electronic document processing. Using image technology, external information is registered and added to an electronic repository. Internally created electronic documents are also added to the electronic repository. Consequently, this repository should be able to deal with any kind of document, disregarding the structure of the document and the file-format. It should be able to deal with images, word-processing files, spreadsheets files, etc.

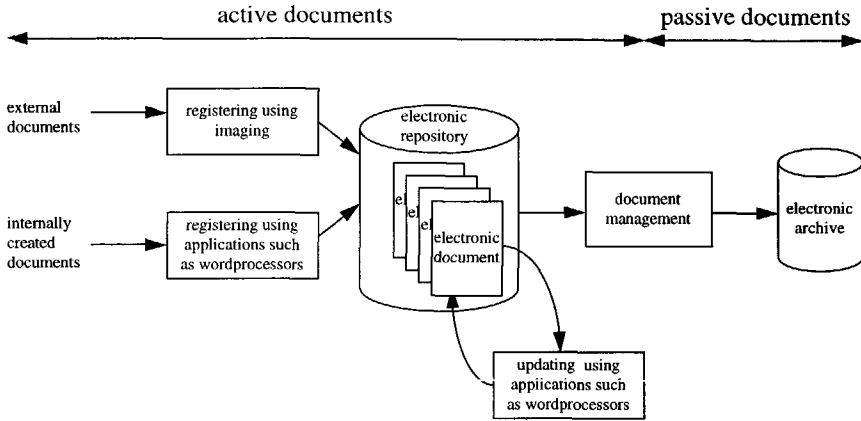


Figure 4.11 Basic structure of electronic document processing

Documents in the electronic repository will be used during the investigation. They will be viewed, edited, exchanged, printed, etc. The document's information content can be changed, employing the same application used to create the document. If a case is closed, the file will be electronically handed over to document management, shifting from the active to the static phase. Hence, it is removed from the electronic repository and added to the electronic archive. The aims of a repository and an archive differ. These aims are derived from the accessibility of the information. The aim of a repository is to offer complete and fast information regarding active cases. Consequently, the information is made accessible by relating it to active cases. The aim of an archive is long term preservation of valuable information. Information is selected and made accessible using additional



criteria. These criteria reach beyond the investigation the information originally related to. Information with a low value is deleted.

The informational and procedural measures, which are part of the design for EDM, are derived from the basic structure of electronic document processing. The informational and procedural measures should answer the following questions:

- Which documents should be converted from hard-copy to electronic documents?
- Which hard-copies should be deleted and which should be archived?
- Which criteria should be employed to make the electronic repository and the electronic archive accessible?
- When and how should documents be removed from the electronic repository and added to the electronic archive?
- Which documents may be deleted from the electronic repository, without adding them to the electronic archive?

The answers to these questions are driven organizationally and archivally instead of technologically.

Figure 4.11 shows the life-cycle of documents, which is quite similar to electronic documents and hard-copies. Figure 4.11 fails to show the integration of document management and process control. In order to integrate document management and process control it is necessary to link the latter with the electronic repository.

#### **4.3.2.2 The electronic document management architecture**

Figure 4.12 shows the EDM architecture which integrates document management and process control (see also De Jong [1995] and Popkin [1993]). Dedicated applications contain structured information, using regular databases. Electronic documents are stored in the repository. Dedicated applications, supporting tools for process control and tools for document manipulation, have access to documents in the repository. The use of documents can be triggered by a dedicated application, a tool for process control, or a tool for document manipulation. Figure 4.12 also shows an element named 'document management', which represents tools for managing the electronic repository. The functions of each element are described briefly.

##### *Process control*

Process control involves functions regarding the workload of the organization, e.g. registering new cases, the status and the planning of cases, and an action list.

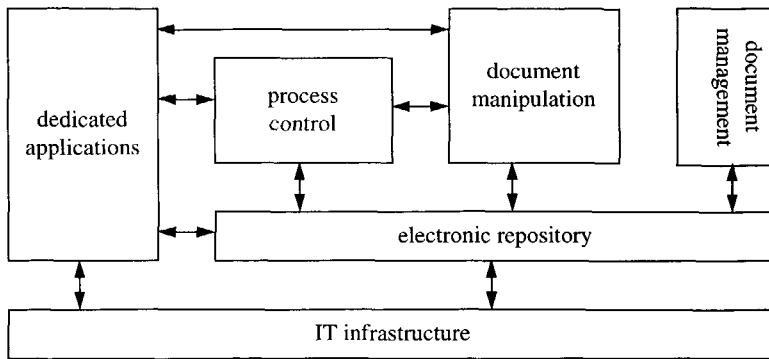


Figure 4.12 EDM Architecture

*Document manipulation*

Document manipulation includes document modification and document exchange (see section 2.3). The modification of documents is determined by the applications. For instance, a word-processing file can only be edited while using a word-processor. Document manipulation includes each application used in the Investigation Service. This can be used in order to change the information content of electronic documents. Examples are a word-processor and a spreadsheet. Document exchange includes functions to send and receive electronic documents and to register document exchange.

*Electronic repository*

The electronic repository contains the electronic documents and offers functions to store and retrieve them. Additionally, it has facilities for version control and access checking. The latter is of great importance for dealing with confidential information. The electronic repository includes electronic documents and the related meta-information. Different kinds of documents require different meta-information. A document descriptor describes the meta-information important to a certain document. Consequently, a document descriptor lists the attributes for each type of document.

From an architectural point of view, the electronic repository and the electronic archive, as described with respect to the basic structure of document processing, are similar. They only differ in their document descriptors.

### *Document management*

The management functions of the electronic repository are implemented in the element 'document management'. It includes functions to:

- control the document descriptors;
- control the documents;
- control the user's rights;
- control the applications which have access to the electronic repository.

### *Dedicated applications*

The applications used by the Investigation Service are described in section 4.2.4. Examining these applications more closely reveals that only the IRS case system and the Investigation Support System are dedicated applications. The PRS system is used to register mail, whereas the RIS95 system is used for process control. Consequently, these two applications are unnecessary when implementing the EDM architecture.

The IRS case system and the Investigation Support System are dedicated systems which generate electronic documents. These documents will be stored in a research file and added to the electronic repository. Consequently, an interface has to be defined between the IRS case system and the Investigation Support System on one side, and the electronic repository on the other.

### *IT-infrastructure*

The IT-infrastructure, finally, includes networking and data communication facilities, hardware, operating systems, printing facilities, etc. Due to the Investigation Service's requirement to make use of the IT infrastructure of the Ministry, the IT infrastructure sets boundaries to the design and implementation of the EDM architecture.

## **4.3.2.3 Informational and procedural measures**

### *Informational measures: making information accessible*

The investigation process is case-oriented. It has a clear beginning (a report of alleged fraud) and ending (e.g. the issue of a summon). Documents used, both electronic and hard-copy, relate to a case. The case involves the dominant criteria to improve the accessibility of information. This is especially true from the investigator's point of view. From a managerial point of view, other criteria are also of importance, such as the status of a case, the type of alleged fraud, etc. To determine which meta-information regarding a document will be registered, both the operational and the managerial level are taken into account. Notice that, instead of relating to a document, some

meta-information does relate to the dominant criteria to improve the accessibility of information: a case. Figure 4.13 lists the document's attributes to be registered. An enumerative list of attributes is given in De Jong [1995]. The attributes 'case identification' and 'PRS identification' refer to the system currently used. These attributes are necessary to refer to documents already created. Until the RIS95 and PRS are no longer used, these attributes will be employed for new documents.

Attribute	Description
1. document identification	unique identification of the document generated by the system
2. document description	free description of the document content / abstract
3. author identification	unique user identification
4. type of document	the type of document determines document indexing, retention period and deleting
5. creating application	application by which the document is created
6. user's rights	this attribute contains the user's rights for groups of users
7. additional comments	free textual space
8. date of sending	the sending date the document contains, which is especially of importance to scanned documents
9. action to be taken	this attribute identifies the organizational unit currently responsible for the document
10. date of creation	--
11. active/passive document	--
12. long term retention required	this attributes denotes that a document has to be transferred to the archive as soon as the relating case is closed
13. archiving date	--
14. archiving directory	directory in which the document is placed
15. relating file	this attributes binds a number of documents to one file
16. case identification	case identification according to the RIS95 currently used
17. PRS identification	document identification according to the PRS currently used

Figure 4.13 List of document attributes

*Procedural measures*

Currently, investigators often work at home, use formal and informal information, and have a high degree of independence regarding task execution. Implementing the EDM architecture requires the registration of each document used in an investigation and the transformation of paper to electronic documents. Investigators receive a large number of documents. Consequently, investigators will either have to transform these documents themselves, or forward them to the secretarial office. In order to enable this system to work, transforming or forwarding should occur regularly, for instance every Friday. It is importance to notice that this procedure will reduce the investigators' independence, while enabling management to check the investigational progress.

The procedural measures deal with the following questions:

- The evidential value of electronic documents, both internal and external, need to be guaranteed.
- In case documents are exchanged with other organizations, the authenticity of electronic documents, especially those created by the Investigations Service, need to be ensured.
- Electronic documents are often printed on paper, after which information is added (e.g. the signature of a witness). This kind of added information also needs to be managed.

Scan list			
Type of document	Scanning required	Forwarding paper equivalent to the records keeping unit for retention	Deleting paper equivalent after scanning or using
written information with evidential value	X	X	
memos and reports regarding cases which contain no evidential information	X		X
HIS' IRS listings	X		X
listings of the automated population administration from a municipality	X		X
policy memos from other organizations	X		X
letters from the public investigator regarding the legal procedures of a case	X		X

Retention list			
Type of document	Electronic document	Forwarding hard-copy to the records keeping unit for retention	Deleting paper equivalent
written and signed statement of a suspect or a witness	X	X	
conclusions of the investigation	X		X
report on the progress of the investigation	X		X
request for information	X		X
calling a suspect for a statement	X	X	
report of an examination 'on location'	X		X

Figure 4.14 Fragment of a scan list and a retention list

Dealing with these issues is only possible when using hard-copies. For instance, a witness's statement will only hold evidential value if signed and printed on paper. Consequently, these archival issues impede the paperless implementation of the investigation process. Involving incoming documents, a so-called 'scan list' is constructed summarizing the documents to be stored on paper or to be deleted after scanning. A so-called 'retention list' summarizes the documents created internally, which are to be stored on paper. Figure 4.14 provides an example of these lists.

#### 4.3.2.4 Implementing the design

The implementation of the design for EDM has an impact on both the organizational processes and the IT of the Investigation Service. This impact is presented below.

##### *Impact on organizational processes*

The implementation of the design will result in a shift of responsibilities:

- investigators will become partially responsible for the registering of documents and the progress of ongoing work, whereas presently only the secretarial office is responsible for the registration;
- the secretarial office, instead of the records keeping unit, will decide on the retention of documents;
- in the task of the records keeping unit, a shift will occur from routine selection of paper documents for retention, to the management of the scan list, the retention list, and the information content of the EDM system.

The shift of tasks will have a great impact on the records keeping unit: the required skill will shift from 'high routine information selection' to 'organizing document management'. Employees working at the records keeping unit may regard this shift as a threat to their jobs, which may lead to resistance. To avoid this resistance, the records keeping unit is asked to participate in the design of the EDM system [De Jong 1995 pg.125]. The involvement focused on categorizing documents, the design of document descriptors, and document handling procedures. By becoming involved in the design process, the employees became aware of the possibilities to enrich their jobs by EDM. The secretarial office and the investigators were involved in the design process with a focus on the importance of document management and document registration.

##### *Impact on the IT*

The IT infrastructure of the Investigation Service is not capable of supporting large scale electronic document processing. No high capacity network exists, linking the office in The Hague with the regional offices. The majority of the hardware used has built-in modems, supporting a baud rate of 9600 and 9.5" screens. The Investigation Service uses MS-DOS applications. Implementing the EDM architecture requires an investment of the Investigation Service both in hardware and in software [see De Jong 1995]. Allowing the investigators to work at home and enabling them to use the electronic repository of the central office, data communication facilities are required, not only between the regional and central office, but also between the home addresses of the investigators and the central or regional office. Asking

investigators to work at regional offices, will increasingly reduce their task-freedom. Consequently, the investigators' resistance is likely to be evoked.

The EDM architecture is implemented in a pilot at the central office in The Hague, using the EDM tool SoftSolutions for MS-DOS. The choice for SoftSolutions is based on the following considerations:

- SoftSolutions offers the functions required to implement the EDM infrastructure. It is mentioned that other applications, like PC Docs, offer similar functions. The choice for SoftSolutions was not preceded by an enumerative analysis of each EDM application: finding one meeting the standards, satisfied [De Jong 1995].
- SoftSolutions was first taken over by Wordperfect and later on by Novell. Novell's Netware and Wordperfect are the standards of the Ministry. SoftSolutions is in line with these standards. SoftSolutions and Wordperfect operate in an integrated manner [PerfectUser 1995].
- SoftSolution is available in a MS-DOS and a Windows version. These versions are compatible with the document attributes. The Ministry is expected to use Windows in the future.

Within the pilot, SoftSolutions is merely integrated with the word processor used by the Investigation Service. This is result of the fact that integration with other systems requires an adjustment of the Investigation Service's IT Infrastructure and additional software development of dedicated systems. This is not possible within the pilot. Consequently, the PRS and the RIS95 systems remained operational during the pilot.

#### **4.4 Discussion**

The management of the Investigation Service encounters a number of problems which can be reduced to one reason: the lack of control regarding the investigation process. This lack results in a large number of investigations not completed within terms.

Section 4.2 describes the investigation process. It shows its well-structuredness, whereas activities and the information used are ill-structured. Section 4.3 shows that document management and process control are implemented separately within the Investigation Service, both organizationally and technologically. Due to the fact that employees responsible for registering possess limited knowledge regarding the content, documents are sometimes registered incorrectly. In case information is missing, document registering employees contact investigators. This consumes time, which explains why registration lags behind. Furthermore,

the status of documents is delayed due to the fact that those responsible for registering do not regard it as part of their primary tasks. In case of high work pressure, registering receives a low priority.

The EDM architecture, which is part of the design for EDM, technologically integrates document management and process control. This integration thrives on the transformation of paper to electronic documents. Despite the possibility to strongly reduce the number of paper documents, these will be used during the investigation process on account of its evidential value. Consequently, paper and electronic documents will continue to exist within the Investigation Service. The design of EDM deals with this complexity by means of a scan list and a retention list. These lists inform the users of the document to be retained on hard-copy. In order to make EDM operational, the correct use of these lists needs to be enforced.

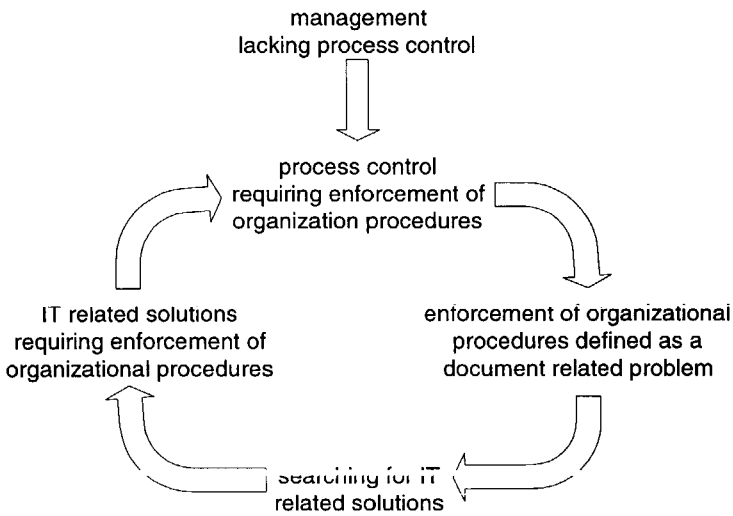


Figure 4.15 A dilemma: returning to the initial problem

Figure 4.15 visualizes this line of reasoning, making clear that one returns to the initial problem of enforcement. It also illustrates EDM being used to enable organizational change. In case the problem of enforcement can not be solved in its current setting, enforcement might be implemented as one of the critical success factors of EDM. Consequently, organizational support to the enforcement of organizational procedures is generated.



## **5. Case 3: Ad-hoc document usage: the department of spatial planning**

The department of spatial planning (DSP) is a division of the Ministry of Housing, Spatial Planning and Environment. The DSP, which existence is based on legislation<sup>25</sup> [Heijnis 1994], is responsible for the town and country planning in the Netherlands.

This case study was conducted in 1994. The subject of this case study was document use by the management board of the DSP. Similar to the case study of chapter 4, this case study is limited to an organizational unit which executes a number of organizational processes. This case study is described in details in [Uijlenbroek 1994 and 1995]. The instruments used to collect data are presented in appendix A.3.

### **5.1 Department of spatial planning: mission and organization**

The mission of the DSP is to 'create conditions which enable social and economic development while improving the quality of the environment'<sup>26</sup> [VROM 1994]. Town and country planning has become increasingly important in the Netherlands due to the increasing population, the economic development and the increasing need for transportation, in relation with the country's size. The DSP is responsible for the design and implementation of the spatial planning policy. During the process of policy design and implementation, decisions were held in consultation with other governmental organizations, such as ministries, provinces and local authorities. Given the multiple use of space, in order to deal with conflicting interests, consultation is of great importance.

The primary task of the DSP, derived from the legislation regarding spatial planning<sup>27</sup>, is to support the minister in preparing governmental policies. The DSP executes this task by [Staatsblad 1985]:

- maintaining valuable relations with other governmental agencies;
- conducting research regarding town and country planning and publishing the results in order to attribute to the transfer of knowledge;
- supporting governmental planning committees;

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<sup>25</sup> Wet op de Ruimtelijke Ordening, art. 52 en Besluit op de Ruimtelijke Ordening 1985, art. 31.

<sup>26</sup>In Dutch: 'Het scheppen van voorwaarden voor moderne maatschappelijke en economische ontwikkelingen op een dusdanige wijze dat de kwaliteit van de omgeving wordt behouden en waar mogelijk wordt verbeterd' [VROM 1994].

<sup>27</sup> Art.52 juncto art.2 Wet op de Ruimtelijke Ordening, art. 30 Besluit op de Ruimtelijke Ordening.

- supervising the compliance of planning legislation;
- supplying governmental agencies with information;
- yearly preparing of a planning study.

The DSP acts in close co-operation with the department of housing, the department of the environment, the Ministry of Transport and Public Works, and the Ministry of Agriculture and Fisheries. The DSP maintains a number of preparatory committees which advise the government regarding intended governmental policies. The formal consultation of other ministries occurs in these committees. The result of a consultation is forwarded to the management board of the DSP. Consequently, most contacts between the DSP's management board and other governmental agencies are structured by these committees. It is important to notice that the latter simultaneously structures document exchange.

#### *Organizational structure*

Figure 5.1 shows the organizational structure of the DSP. The formal organization contains the management board, two business units, two project units, one supporting unit, and four legislation supervising units. Each unit includes several sub-units. The management board reports to the minister. The Directorate of Spatial Research and Planning (DSRP) and the Directorate of Implementation and Policy Co-ordination (DIPC) are business units. Each business unit is supported by a similar specified project unit. The project units execute innovative short-term projects. Projects evolving into long-term activities are transferred to a business unit. The Directorate of Management Support (DMS) is responsible for personnel management, information management, automation, financial management, and organizational development. The DSP contains four legislation supervising units, which are regionally organized. These units inspect the implementation of governmental planning policies by other governmental agencies, such as municipalities and provinces (or regions).

No employees are assigned to the project units. In order to execute a project, employees are hired from DSRP or DIPC, or both. This construction guarantees the dispersion of knowledge between the project units and the business units. The projects are controlled by the managers of the project units. They report to the management board. The management board consists of 5 persons: a chairman, a vice-chairman and one representative of each directorate. The management board is assisted by a secretary. A manager of a project unit only attends a meeting of the management board if one of his/her projects is on the agenda.

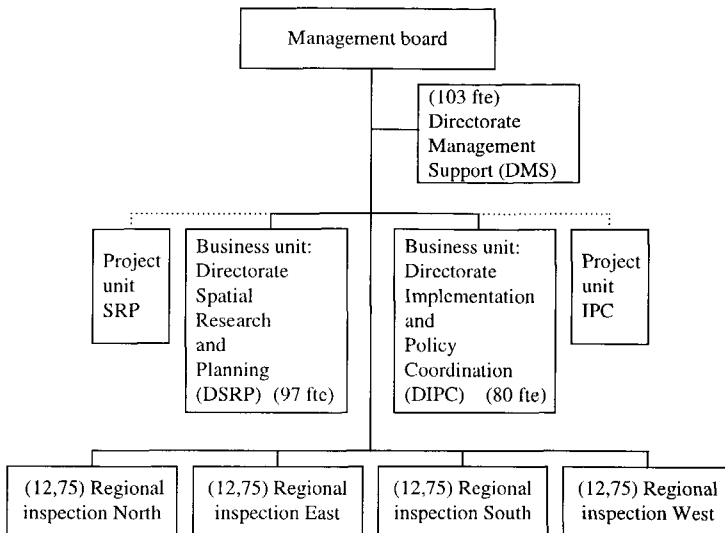


Figure 5.1. Organizational chart of the department of Spatial Planning

The majority of DSP's employees are highly skilled professionals on a certain field of interest regarding spatial planning. The DSP has 331 full-time equivalent employees. In figure 5.1, the number of employees for each organizational unit is presented. The 1994-budget of the DSP was approximately f 67 million [VROM 1994].

#### *Problems encountered by the management board*

The following document-based problems are encountered by the management board [Uijlenbroek 1994]:

- The management board needs a complete file for decision making. Complete files are not available at the DMS. In case a complete file of an issue is required, the employee dealing with the issue, who often has a complete file in his/her personal archive, needs to be contacted.
- The management board has little information regarding the follow-up of a decision. In case this kind of information is required (e.g. status information, planning, etc.), the employee responsible needs to be contacted. In case of an immediate need for information, the inability to contact the employee responsible may cause problems.
- The issues on the agenda of the management board, especially short-term issues, often have high priority. The documents which contain the information needed by the management board for decision making are only available one or two days prior to the board meeting. The time pressure complicates the decision making. It seems, however, that

organizational units know in advance that certain short-term issues have to be discussed by the management board. These kinds of issues are not pre-announced.

The following section describes the use of documents by the management board in detail. Section 5.3 presents a design for EDM which solves problems mentioned above.

## 5.2 The management process and document manipulation

### 5.2.1 Interorganizational co-operation

The DSP provides professional and secretarial support to a number of preparatory committees. A number of these committees are established by law. The management board takes notice of the minutes and the reports of these committees. Most external documents received by the management board are derived from these committees. Figure 5.2 shows these committees and the number of documents delivered to the management board.

Committee		Number
Staff meetings	[Ambtelijke staf]	25
Staff spatial planning	[BDRO]	2
Policy development staff	[Beleidstaf]	9
General policy development team	[Beleidsteam beleid]	1
Development international policy team	[Beleidsteam Internationaal (i.o.)]	1
Policy development supporting units	[Beleidsteam ondersteuning]	1
Policy development SRP team	[Beleidsteam ROP]	6
Policy development IPC team	[Beleidsteam UCB]	16
Governmental consultation	[Bewindsliedenstaf]	31
Commission OBP	[Commissie OBP]	3
Meetings with the secretary general of DSP	[Contactbesprekingen SG-dgRO]	3
Inter-departmental staff meetings	[DGRO/DGM-staf and DGVH-staf]	34
DIB-consultation	[DIB-overleg]	2
Meetings with the minister	[Gesprek met de Minister]	1
Information and automation units	[I&A-staf]	1
Regional Inspector meetings	[Inspecteursbespreking]	5
Consultation of the secretary-general	[Overleg DVEB-DGRO]	1
Governmental Spatial Planning Committee	[RPC/RMC]	6
Counsel of DSP and Environmental Protection	[RROM]	1
Meetings with the secretary generals	[Secretarissen Generaal]	1
Study meetings	[Studiestaf]	1

Figure 5.2 Number of documents sent from committees to the management board in 1993 (original Dutch name in brackets)

Figure 5.3 shows the information exchange of the DSP and one of its committees, the Governmental Spatial Planning Committee<sup>28</sup>(GSPC). The arrows (A) and (B) denote document exchange between the committee and

<sup>28</sup>In Dutch: Rijksplanologische Commissie (RPC).

the DSP. Examples of these documents are agendas, minutes, memos, etc. Documents exchanged with other ministries (C) are minutes, drafts of, and amendments to policy papers. Figure 5.4 summarizes these documents in detail.

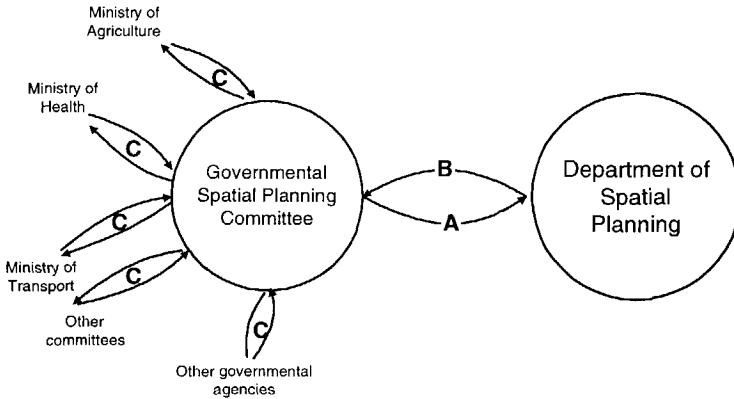


Figure 5.3 Interorganizational co-operation

Figure 5.5 shows which ministries have delivered documents to the GSPC. Figures 5.4 and 5.5 have matching categories. The high number of documents received from the Ministry of Housing by the GSPC (59%) is explained by the support DSP offers to GSPC. Please notice that the DSP maintains the GSPC. The information exchange with the GSPC is typical for the other committees shown in figure 5.2. Uijlenbroek [1994] describes the GSPC and its document use in detail.

	Type of document	Number
A	Minutes of the meeting	35
B	Memorandum of the minister founding his request to give advice	2
C	Agenda	24
D	Memo to be discussed in the meeting	26
E	Memorandum of the secretary to the GSPC preparing an advice of the GSPC	27
F	Request of the minister to give advice	25
G	(Draft) advice of the GSPC to the minister	30
H	Advice of other advising committees	9
I	Amendment to the policy paper by other governmental agencies	12
J	Policy paper	54
K	Appendices to policy paper	46
L	Statement of absence	16
M	Additional writing sent on to a policy paper	8
N	List of incoming and outgoing documents	3
X	Others	5

Figure 5.4 Documents processed by the GSPC in 1993

The committees shown in figure 5.2 receive professional and secretarial support from the DSP. These committees operate independent of the DSP. Quite regularly, however, they are assisted by employees of the DSP in writing documents either containing the decision or used in decision making. From an organizational point of view, document exchange between a committee and the DSP is interorganizational. In reality, however, it is forwarding a document to the secretary of the committee, who is also an employee of the DSP. This is considered to be internal document exchange. Consequently, document exchange is not always as obvious as figure 5.3 shows.

External source	A	B	C	D	E	F	G	H	I	J	K	L	M	N	X
PM's office															
min. of Internal affairs											1				
min. of Foreign affairs											1				
min. of Defense												1			
min. of Economy								3		3	1				
min. of Finance									1						
min. of Justice												1			
min. of Agriculture				4		4			1	1	2	1			
min. of Education															
min. of Social Security															
min. of Transport				3		12			1	22	20				
min. of Housing	34	2	24	19	27	9	30		3	14	14		8	3	3
Min. of Health												7			1
others	1							6	6	14	7				1

Figure 5.5 Documents delivered by other governmental agencies to the GSPC in 1993 (the categories A, B, etc. relate to figure 5.4)

**5.2.2 Process and activity structure**

Every week, the management board meets in a formal meeting. The formal meeting is prepared during an informal lunch-meeting. During the lunch-meeting information is passed involving political developments. Furthermore, the draft-minutes of the previous formal meeting and the agenda for the following meeting are confirmed. In addition, a few topics requiring urgent solutions are discussed. During the lunch-meetings, it regularly occurs that no minutes are taken. In the formal meeting, the items on the agenda are discussed. Decisions made by the management board are always based on a policy paper, which needs to be signed by a director. This implies that at least one member of the management board will agree with the policy paper. The director responsible will return the board's decision to the author of the policy paper. The secretary takes the minutes of the formal meeting. After the minutes are approved, the latter makes sure that these are distributed.

The agenda of a formal meeting contains of a number of regular items, such as the minutes of the previous meeting(s), actions to be taken, minutes of

other (politically sensitive) committees, meetings in the country, etc. Each organizational unit may add items to the agenda by reporting it to the secretary. After consultation with the director responsible, the secretary may postpone issues to a next meeting. Papers belonging to listed agenda items should be passed on to the secretary, who is responsible for writing a summary and compiling the meeting file. The manner in which documents are to be delivered to a formal meeting is described in a book of procedures [RPD 1993 and VROM 1993].

The decisions made by the management board are part of a larger organizational process. The management board is involved in almost all organizational processes. Decision making is just one phase of these processes. The procedures for document delivery and adding items to the agenda of management meetings are described independently of organizational processes [RPD 1993, VROM 1993]. These procedures only relate to the decision making process. This is illustrated in figure 5.6. Examples of processes are the budget process, dealing with questions of the 'Tweede Kamer'<sup>29</sup>, preparing ministerial meetings, etc.

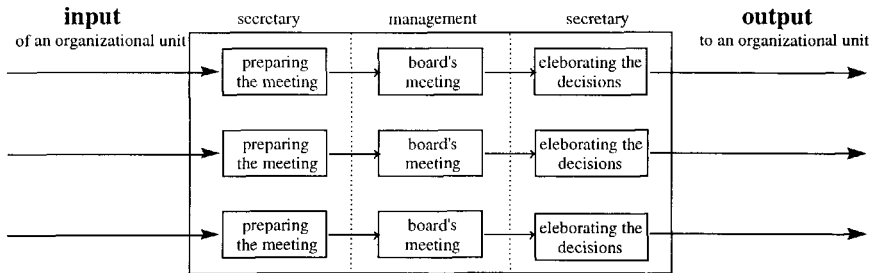


Figure 5.6 Management board: the decision making phase of organizational processes

The activities shown in figure 5.6 are ill-structured. The meeting is chaired according to a certain structure, which is included in the agenda. For each meeting an agenda is established. The ill-structuredness of a 'formal meeting', its 'preparation' and the 'elaboration on the decisions', is substantiated by the fact that each meeting is structured differently. Besides presenting a task structure of these activities, Uijlenbroek [1994] also summarizes a number of real-life exceptions. The exceptions illustrate that in order to structure these activities, a high level of abstraction is required. Consequently, the contact with reality is diminished. The following examples illustrate the ill-structuredness of these activities.

<sup>29</sup>The Dutch House of Commons.

- New political developments and issues emerging in the media often require an alert reaction of the DSP. This may lead to situations which were not expected in the written procedures concerning decision making. Usually, the chairman of the management board, assisted by the secretary, decides how to deal with these unexpected situations. Updating the procedures does not seem sufficient to eliminate unexpected situations.
- Following the appropriate procedures is rather time consuming. In case an urgent solution is required, procedures are not followed.
- The diversity of issues, the number of people and organizations involved, compared to the frequency of the process (often occurring just once) make it difficult to structure processes in advance.

### 5.2.3 Document manipulation

#### *Document exchange*

The management board receives a large number of documents. During the process of decision making, information used by the management board is always presented in documents. These documents are often written by employees of the DSP. Obviously, the management board is only confronted with a small portion of the documents created within the DSP, namely documents sufficient for decision making.

	Document type	Number of occurrences
	Documents used in management meetings	
A	Notes made during the lunch meetings	39
B	List of actions to be taken	42
C	Agenda	49
D	Minutes of formal management meetings	44
	Documents for decision making	
E	Policy papers	241
F	Summaries of policy papers	184
	Documents for informational purpose only	
G	Agendas of other commissions and committees	14
H	Lists of ministerial meetings and visits	39
I	Questions of politicians	32
J	Ministerial agenda for the coming week	38
	Others	
K	Minutes of other commissions and committees	151
L	Number of issues dealt with verbally	82

Figure 5.7 Documents processed by the management board in 1993

In 1993, the management board held 49 formal meetings and processed 873 documents, which are categorized in figure 5.7. Figure 5.2 showed that 151 documents (about 17%) derived from 22 committees (figure 5.2 corresponds with category K of figure 5.7), and 241 policy papers were used in decision



making (see appendix C). Approximately 123 documents were received by the management board for informational purposes only. The policy papers were written by a total of 83 employees. Figure 5.8 shows that in 1993 only three authors wrote over ten policy papers, while 39 authors only wrote one policy paper. Of 16 policy papers the author is not known. Documents were exchanged on hard-copy only.

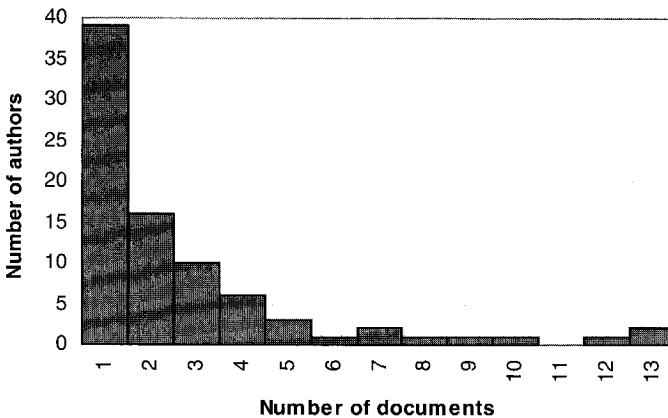


Figure 5.8 Distribution of documents delivered in 1993

#### *Document manipulation*

In order to create documents, authors use desktop applications like a word processor, a spreadsheet, etc. The electronic version of a document is only available to the author of the document's most actual version. Due to the ill-structuredness of the activities, the sequence of document manipulation is unclear.

The records keeping unit receives a copy of the set of documents used in formal meetings. This set is divided into a number of fixed categories (e.g. agenda, minutes, action list, memo used in decision making, etc.). For each category, the documents are stored chronologically. Policy papers are categorized by author, since each author uses a unique system of document identification. Policy papers are stored according to these systems. Documents intended for informational purposes only (e.g. minutes of committees), are expected to be stored elsewhere (e.g. the archive of the committee). These are therefore destroyed.

#### *Significance of documents*

Due to internal and external accountability, documents used by the management board in decision making are highly significant. The DSP

prepares governmental decisions. Regarding these decisions, account has to be given to the Dutch house of commons. External accountability is therefore particularly important. Furthermore, from a cultural and historical point of view, documents used in decision making are highly significant. The decision making processes in which these are used, occur in a political context. They relate to issues which might have severe influence on society (e.g. the construction of a high speed train, the expansion of Schiphol Airport, etc.). In the future, these kinds of decision making processes are likely to be studied. Studying these processes requires documents on which decisions were based.

#### *Structure of information*

Figure 5.7 summarizes documents processed by the management board. Almost each document includes ill-structured information. Policy papers in particular contain rich information, combining text with tables, figures, maps, charts, photographs, etc. Policy papers used by the management board for decision making often are drafts. Alterations will be implemented by the author. The management board is often supplied with separately compiled maps, charts and photographs. Only in the final version of the policy paper maps, charts and photographs are integrated into the policy paper.

Figure 5.7 also shows that the management board receives hard-copies of the minutes taken by several committees or commissions. These minutes only contain unstructured text, whereas 36% of the GSPC documents contain rich information [see also Uijlenbroek 1994]. The management board only receives rich information from its committees or commissions, in case a policy paper is forwarded to the management board.

#### **5.2.4 IT support of document use**

Documents used by the management board are compiled by an employee, who uses a desktop application, such as a word processor or a spreadsheet. Documents are forwarded to the management board on hard-copy. IT, as a tool, is not employed by the management board.

Except for the minutes of the board meetings, documents are always exchanged on hard-copy. These minutes are sent on hard-copy to a small number of employees. The secretary transfers the electronic equivalent to a directory to which DSP's employees have access. Every employee interested in the minutes can take notice of them. The minutes can easily be located in the directory, because the secretary uses a naming convention which

includes the date of the meeting. The minutes are not accessible based on the topics they include.

### **5.3 Designing electronic document management**

Section 5.1 summarizes a number of document-based problems encountered by the management board. This section presents a design for EDM. This was created in order to support the board's use of documents, and to eliminate the problems encountered. Prior to the presentation of the design, the document problems will be related to both process control and document management.

#### **5.3.1 Document related problems**

The following bottlenecks are encountered by the management board: completeness of files, scheduling of short-term issues, following up after decision making, and relying on personal archives. These problems relate to process control and document management.

##### *Process control*

Process control by the management board is currently implemented by using a list of organizational activities and projects [VROM 1994]. This list is updated yearly in accordance with the budget cycle. Only long term activities are added to this list, which in fact contains DSP's organizational output. These activities are often long-term.

The secretary uses the list of organizational output to schedule long-term issues on the board's agenda. These will be discussed by the management board. After consulting the responsible director, employees put short-term activities on the agenda. Currently, DSP does not use a structured list of short-term activities.

Problems encountered by the management board indicate a lack of information regarding the status of organizational processes, occurring both prior to and after decision making. Problems with respect to status information prior to decision making only relate to short-term issues. Without pre-announcement, an employee puts these kinds of issues on the agenda of the board's formal meeting. The management board establishes priorities regarding these issues during the lunch-meeting. During the formal meeting, important issues are discussed. Problems with respect to status information after decision making relate to both short-term and long-term activities. Currently, the management board takes the initiative in acquiring status information regarding organizational activities. In order to obtain the

information required, either the secretary or a director contact the employee involved. The management board lacks an overall view on both short-term and long-term activities.

#### *Document management*

DSP creates its documents electronically, while only hard-copies are exchanged. The records keeping unit only deals with paper documents. To obtain an electronic version of a document one has to contact its author.

Only official documents discussed in committees are stored. The initiative to store important documents which are not (yet) discussed during a meeting of any committee, should be taken by DSP's employees. Nevertheless, this rarely happens. Consequently, the records keeping unit rarely possesses a complete file. As a result, employees searching for information which also might be found in the archive, usually contact a colleague. This stresses the importance of personal archives, and accordingly reduces the importance of the records keeping unit. Consequently, employees focus on completing personal archives and disregard the services of the records keeping unit. This explains the incompleteness of the files. The process described here seems to have resulted in a vicious circle.

### **5.3.2 A design for electronic document management**

According to the definition of document management (section 1.1.1), the design for EDM includes technological, informational and procedural measures. The design focuses on supporting process control and document management, which is in line with Lohman et.al. [1996 p.12]. They have concluded that IT support of top-management is limited to improving the accessibility of information (in this case documental information), control of actions (in this case process control), or both.

#### **5.3.2.1 Design issues**

##### *Process control and document management*

Currently, DSP uses no IT tools to support process control or document management. The board's process control is currently limited to long-term issues, which are put on the list of organizational output. Document management is limited to paper documents. An issue on the board's agenda is always accompanied by a number of paper documents. These documents are often created electronically by DSP's employees. This enables the use of an electronic document repository.

The overall view on both short-term and long-term issues, which the management board lacks, can be solved by implementing a structured list of organizational tasks. This so-called action list should cover the entire organization, containing organizational activities and projects which relate to both long-term and short-term issues. Linking the action list to the electronic repository, would integrate process control and document management.

In order to integrate process control and document management, the action list has to be updated. An up-to-date action list requires a punctual registration of tasks by organizational units dealing with these tasks. Employees should be aware of their obligation towards registering new tasks and the progress made concerning ongoing tasks. This awareness can be stimulated by EDM. Documents should be registered after creation. Furthermore, documents should be linked to tasks. As a result, employees will be stimulated to put tasks on the action list. This action will occur as soon as an employee starts working on a certain task by creating an electronic document. This requires integration of document registering and document creation. By implementing the process mentioned, an electronic repository is created, which enables electronic archiving and assures the completeness of the file.

#### *Electronic document processing*

The basic structure of electronic document processing is shown in chapter 4 (figure 4.11). By taking the document life cycle as a starting point, this structure also applies to document processing by DSP. Compared with the Investigation Service, DSP uses less external information and creates more documents electronically. Consequently, the registration of external information is less important to the DSP than to the Investigation Service. Compared with the Investigation Service, the DSP's problem of enforcement regarding the registration of external documents is less disturbing.

Section 4.3.2 lists a number of questions to be solved in the design for EDM. Due to being derived from the basic structure of document processing, these questions also apply to the DSP.

#### **5.3.2.2 The electronic document management architecture**

The EDM architecture embodies the design of the technological part of EDM. Figure 5.9 shows the EDM architecture for the DSP. Compared to the EDM architecture of the Investigation Service (see chapter 4, figure 4.12), the DSP's architecture includes no dedicated applications. Furthermore, process control is reduced to an 'action list'. These elements of the EDM architecture are presented in gray. The elements shown in figure 5.9 are described in

section 4.3.2. The difference in the architecture derives from the absence of dedicated applications processing structured information, and the ill-structuredness of the management process.

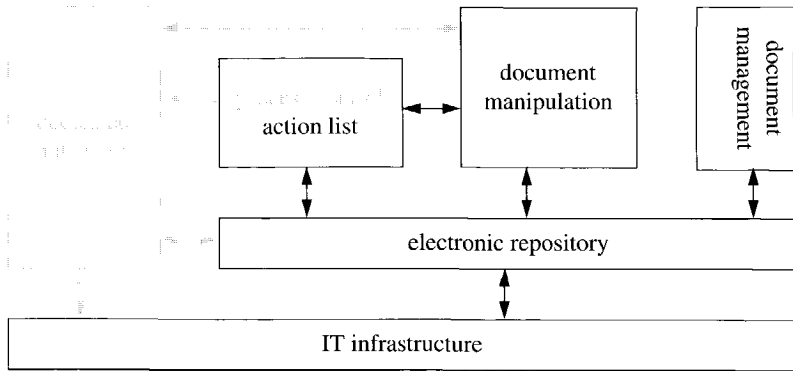


Figure 5.9 EDM Architecture

### 5.3.2.3 Informational and procedural measures

#### *Informational measures: making documents accessible*

The previous chapter argued that improving the accessibility of information should be based on the process structure. The management board operates 'issue-oriented'. Documents should therefore be classified according to these issues. Currently, paper documents are classified by the records keeping unit. A set of documents used for a formal meeting is split up into process-oriented (e.g. agenda, minutes) and issue-oriented documents (e.g. policy papers).

By summarizing tasks on an action list, electronically available on each workplace, one enables authors to make electronic documents accessible. This way of improving the accessibility of documents meets the management board's demand. An employee working on a number of organizational tasks (e.g. issues on the agenda of the management board), however, will not favor this implementation. The employee will require the documents categorized according to the details of the organizational process he/she operates in. The structure of these tasks, however, is not known in advance. Consequently, the use of different levels of making documents accessible should be possible. Additionally, involving the implementation of only one process, it should be possible to easily change the categories.

*Procedural measures: responsibilities regarding document management and status information*

The effectiveness of the action list and the electronic repository strongly depends on a punctual registration of both work progress and documents. The procedural measures indicate which organizational functions are responsible for a punctual registration. The following organizational functions are distinguished:

- professional employees whose first responsibility is to deal with issues concerning the content;
- secretarial employees, who are responsible for the support of professional employees;
- management, which among other things is responsible for the assignment of tasks and process control;
- the records keeping unit, which is responsible for document management.

Currently, with respect to hard-copies, secretarial employees and the records keeping unit both take care of document management. They capture documents, register them and make them accessible. Professional employees are not involved in document management, except for identifying the importance of a document. The implementation of the EDM architecture will be accompanied by a shift in responsibilities. This shift involves document management in general, and electronic documents in particular.

Document creators, mostly professional employees, will be held responsible for the registration of electronic documents. This implies a shift of responsibilities from secretarial to professional employees. This shift can merely be implemented if professional employees are supported by IT. Moreover, the registration of documents should become an integrated part of their regular tasks. Professional employees are accurately qualified to assess the significance of documents. They have the expertise to judge the value of documents with respect to a certain organizational process. Professional employees can only register documents appropriately if the process consumes little time. Consequently, the registration will have to be limited to document attributes which either can be registered automatically (e.g. date of creation and change, author, etc.) or are necessary to relate an electronic document to a task. Additional document attributes can be registered by secretarial employees or the records keeping unit in case a document evolves from an active to a passive document. Professional employees will have to register the change of a document's status from active to passive. This change will often occur when a task is ended. This will be noticed when updating the process status. Consequently, after integrating process control and document management, the change from active to

passive documents can be derived from the process status. As a document becomes passive, the records keeping unit will add additional attributes and will consequently determine the retention period.

Document management tasks	Current distribution of responsibilities				Proposed distribution of responsibilities			
	Management	Professional employees	Secretarial employees	Records keeping unit	Management	Professional employees	Secretarial employees	Records keeping unit
Approving the structure for making documents accessible				X	X	X		
Keeping the structure for making documents accessible up to date				X		X	X	
Determination of documents' significance			X	X		X		
Registration of essential attributes			X	X		X		
Registration of process and document status information						X	X	
Determination of the status' change from active to passive			X			X	X	
Selecting documents for retention and deletion				X				X
Registration of additional attributes				X				X
Retention of documents				X				X

Figure 5.10 Distribution of responsibilities

Using the distinguished organizational functions, figure 5.10 shows the current and proposed distribution of responsibilities. The structure used for making documents accessible will be similar to that used for process control. Consequently, the management board has to approve of the structure for making documents accessible. This structure will be kept up-to-date by both professional and secretarial employees. They should add new organizational tasks to the structure. Currently, the records keeping unit determines the structure for making documents accessible and keeps it up-to-date. Figure 5.10 shows a shift in responsibilities with respect to active documents. Passive documents will remain the responsibility of the records keeping unit.

**5.3.2.4 Implementing the design**

The design for EDM is based on the integration of process control and document management. An important aspect of this integration is that the document creator specifies the task a document relates to. This requires a structured list of these tasks, for instance based on organizational processes, or output of policy areas. The DSP does not have a particular structure containing all organizational activities. The list DSP uses does not contain short-term issues. Furthermore, it is only yearly updated. The



structuring of organizational activities has to occur prior to the design and implementation of EDM.

Currently, employees are not aware of their responsibility to pre-announce issues to the management board. That is, employees are not triggered to pre-announce issues. This relates to the enforcement of organizational procedures (see also chapter 4). The first responsibility of professional employees is to deal with the issue and prepare it for the board's decision making. Although required to register the task a document relates to, an employee is not released from his/her obligation to pre-announce the issue for decision making. An up-to-date action list does not suffice for scheduling issues on the board's agenda. One also has to estimate when the issue is ready for the board's decision making. This estimation can only be made by the employee dealing with the issue. Consequently, the use of IT does not release employees from their obligations towards pre-announcing issues. Chapter 4 ended with a similar dilemma: returning to the initial problem, the enforcement of organizational procedures, which in this case relates to the pre-announcement of issues by employees.

#### **5.4 Conclusions**

This chapter reveals the confrontation of the management board of the DSP with a number of document-based problems relating to process control and document management. These problems are studied in connection with section 2.3. In this section, the aspects to be taken into account when studying document-based processes, are described.

Section 5.2 shows that the management board's document processing is not one process, but merely the decision making phase of several organizational processes. The reasons behind the document-based problems of the management board are strongly related to these organizational processes. The management board lacks status information regarding these processes. This makes it difficult to schedule short-term issues and monitor the following-up of decisions. Solving these document-based problems requires the implementation of an action list which contains status information. In order to solve the board's document-based problems, the action list should cover almost all organizational processes, since this concerns the management board's involvement. Consequently, solving the board's document-based problems requires a solution which involves each organizational process. In other words: an infrastructural approach to process control is required.

Currently, the DSP relies on personal archives. Solving this problem requires an electronic repository which is linked to the action list. The integration of document creation and registering based on the action list enables the author to make documents accessible. Furthermore, the completeness of files is assured and electronic archiving becomes possible. Implementing this kind of IT enabled solutions, requires a shift of responsibilities towards document management.

The integration of process control and document management requires a structure of organizational activities (e.g. based on policy area, organizational output or process) covering the entire organization. Currently, a similar structure does not exist. Consequently, prior to the implementation of EDM, a similar structure needs to be designed.

The DSP is also confronted with the dilemma of enforcing organizational procedures. This is also dealt with in chapter 4. Employees are not aware of their obligation to pre-announce short-term issues. The implementation of EDM does not release them from this obligation. It will merely be implemented in a different manner. Instead of phoning the board's secretary, the expected dates of decision making will be specified in an EDM system. The implementation of EDM will trigger the employees to register the dates of decision making. Thereby, it contributes to the enforcement of organizational procedures and illustrates the use of EDM as an enabler of organizational change.

## 6. Design approach for electronic document infrastructures

### 6.1 Introduction

It is argued that the information content and the exchange of documents closely relate to both the organizational process and output (see section 1.2.2). Consequently, in order to fully comprehend the information content and the exchange of documents, an understanding of the organizational process in which these are used is required. In order to improve document use, the process should be considered the starting point. This line of reasoning is substantiated by case 1, the IRS case. This case shows that improvement of the execution of the IRS program should be based on an analysis of the IRS process. Analyzing processes raises questions regarding the information that has been exchanged (in the IRS case, information needed to solve disruptions of the primary chain). Furthermore, the existence of documents containing this information is questioned.

The IRS case also shows that document exchange and document manipulation can be exhaustively described with respect to well-structured organizational processes which use well-structured information. Furthermore, case 1 shows that the significance of documents can be substantiated by referring to both the organizational process and organizational output.

Compared with the IRS case, cases 2 and 3 deal with less structured processes. Case 2, the Investigation Service, involves a well-structured process, whereas the activities executed by the investigators are ill-structured. Case 3, the DSP, shows an ill-structured process, with the activities executed by the management board also being ill-structured. The use of documents, and its information content are difficult to predict in cases 2 and 3. For these kinds of processes, document use and its significance can only be described in outline. It is not possible to compile an exhaustive inventory of the documents to be used in the processes mentioned.

Presently, in all three cases, paper documents are mainly used. These documents may either contain well-structured information, ill-structured information, or both. Organizations executing the IRS program use a number of dedicated applications. These applications process structured information, relating to both the execution and the control of the process. The Investigation Service uses dedicated applications for process control and document management. These tools, however, are not integrated. The

management board of the DSP does not employ dedicated applications. The use of dedicated applications in the three cases mentioned, shows that well-structured information is processed automatically. This occurs as often as possible, while data are re-entered if necessary. Ill-structured information is processed manually, even though it might be available electronically.

Case 2 shows that a lack of integration of supporting tools for process control and document management reduces the effectiveness of these tools. One tries to solve this lack of integration by implementing procedural measures, which have to be followed strictly. This, however, rarely happens in real life, particularly regarding document registration. Case 3 supports the conclusion regarding integration of process control and document management. Cases 2 and 3 reveal a different degree in process control. Compared with case 3, case 2 shows a more detailed control of processes. The cases mentioned show that the integration of process control and document management requires the structuring of organizational activities. This does not imply a detailed description of processes, but a list of organizational activities which applies to the entire organization.

This chapter presents an approach to the design of electronic document infrastructures. This approach is based on the theoretical concepts presented in chapters 1 and 2, and the practical experience of the three cases mentioned earlier. Prior to the description of the design approach, the concept 'electronic document infrastructure' is described.

## **6.2 Infrastructural approach to electronic document management**

The concept of 'information infrastructure' is developed with respect to corporate information planning. One of its goals is to contribute to the standardization of technology and data used throughout an organization [Martin 1992]. Like any infrastructure, the information infrastructure is characterized by its universal use [Truijens et.al. 1990, p.IX, Bemelmans 1991 p.197]. The infrastructural approach towards corporate information handling is advocated by a number of authors since the 1980s [e.g. Martin 1982, Gunton 1989, Maes 1989, Truijens et.al. 1990].

The meaning of 'infrastructure' depends on the context in which it is used (e.g. the information content, data communications, but also physical infrastructure) and the level of observation (e.g. global, nation, region, organization, department, etc.). Currently, in the field of information technology, the concept of an infrastructure is often used with respect to data communication [e.g. Barlett 1995, Kahin 1995, Branscomb and Keller 1996].

This research applies the concept of the infrastructure to electronic documents in organizations.

The concept of the infrastructure contains a number of general thoughts relating to each infrastructure, thereby disregarding the context and level of observation [Martin 1982, Truijens et.al. 1990]:

- it assures universal use;
- it requires standardization;
- it limits the freedom of entities using the infrastructure, while enabling interconnection of these entities;
- it has to be long-lasting and fail-proof;
- it provides the responsible authority with a pretext to influence actors using the infrastructure.

The analytical view on information systems distinguishes the following components of an information system [Sol 1992, Brussaard 1995]: hardware, software, people, procedures (for peoples) and data. These five components are also distinguished on an infrastructural level. According to Gunton [1989] and Truijens et.al. [1990], an information infrastructure contains an organizational infrastructure including people and procedures, a data infrastructure, an application infrastructure (software), a communication infrastructure, and a configuration infrastructure (hardware). Some authors use a narrow definition of the information infrastructure, thereby limiting it to the data infrastructure [Martin 1982]. This research, however, uses the definition of Gunton and Truijens et.al.

The concepts 'information system' and 'information infrastructure' were developed when IT was mainly used to process structured information. Martin [1982 p.60], for instance, presents four types of data structures: files, application data bases, subject data bases, and information systems. These four types include well-structured information. No attention is given to ill-structured information and documents. The increasing use of electronic documents requires the enrichment of the concepts 'information system' and 'information infrastructure' with ill-structured information.

In order to deal with ill-structured information, there are two ways to enrich the concepts 'information systems' and 'information infrastructure': by adding electronic documents as a component to these concepts or by incorporating these in the component data. Tools and techniques used for document modeling and processing strongly differ from tools and techniques used for structured data modeling and processing [Van der Meer 1994, p.119]. For example, entity relation diagrams (ERD) are seldom used for modeling

documents, whereas they are often used to model structured data bases. The difference between structured information and documents is also shown in international standards: in order to represent documents, dedicated standards are defined [ISO 1986 and 1989]. The differences in tools and techniques justify the identification of electronic documents as a separate component of an information system and an information infrastructure. Figure 6.1 shows the elements of an information infrastructure, including the electronic document infrastructure.

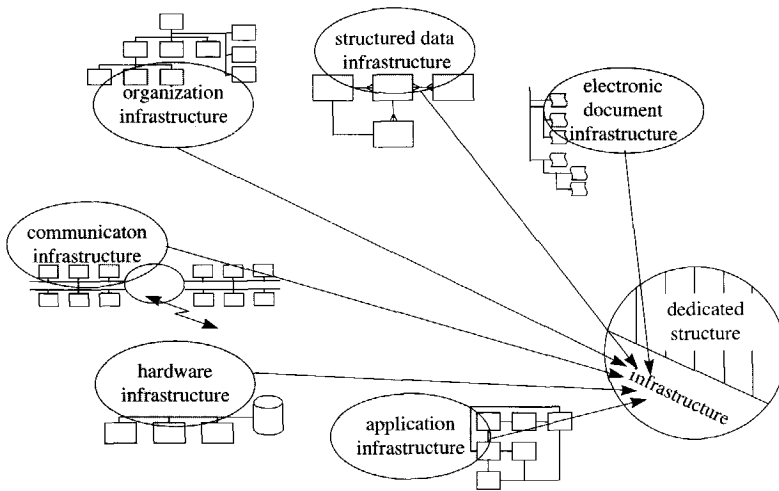


Figure 6.1 The elements of an information infrastructure [after Truijens et.al.1990]

The infrastructural approach to information systems was developed in order to overcome problems encountered in corporate IT management [Gunton 1989 p.40]. Centralized IT planning disregards local requirements, while the absence of a central plan enables proliferation. The latter makes it difficult or even impossible to integrate local systems. Organizational effectiveness and efficiency are reduced by lack of integration. This occurs by disabling free and reliable information exchange between different organizational units. From an IT management point of view, an infrastructural approach enables integration by defining a framework - the *architecture* of the infrastructure - [Martin 1982 p.2, Gunston 1989 p.39]. The latter sets corporate standards, both technological, informational and procedural. Within the boundaries of these standards, local systems can be tuned to local organizational processes.

The architecture of the electronic document infrastructure sets corporate standards for electronic documents. Besides relating to the way documents

are stored and made accessible, these standards also relate to the tools and technology used for document processing. Additionally, these relate to document management procedures, despite the fact that these kinds of standards may be incorporated in other components of the information infrastructure: the application infrastructure, the hardware infrastructure and the organization infrastructure.

### **6.3 Methodology for designing electronic document infrastructures**

Section 2.4 presents an analytical framework for the design of methodologies [Sol 1984 and 1985]. The methodology for designing electronic document infrastructures is constructed according to this framework. Each section discusses a part of the analytical framework. The small picture at the beginning of each section, which is similar to figure 2.6, shows which part of the framework is discussed.

#### **6.3.1 Confining the problem domain**

This research deals with active documents (see section 1.4). The problem domain is limited to organizations which encounter document-based problems. Case 1 shows that routine processes, such as the IRS, should not be supported by the electronic document infrastructure. Consequently, the problem domain is confined to organizations with goal-oriented document-based processes. Cases 2 and 3 are examples of goal-oriented processes.

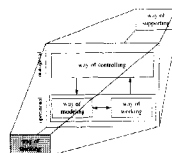
An information system is never an objective as such. Rather, it is used for supporting and controlling real systems [Brussaard and Tas 1980]. Sol [1982] advocates a problem solving approach to designing information systems. By taking existing problems as a starting point in designing information systems, one assures that the design of an information system does not become an objective in itself. An information infrastructure includes the general parts of an information system. Consequently, this line of reasoning also applies to an information infrastructure: taking document-based problems as a starting point in designing an electronic document infrastructure. Cases 2 and 3 include examples of problems which might occur in goal-oriented document-based processes.

The problem domain of the methodology for designing an electronic document infrastructure is the following:

**Problem domain:** Organizations encountering document management problems while executing goal-oriented document-based processes.

### 6.3.2 Way of thinking

The underlying philosophy or 'Weltanschauung' of a design approach is represented in the way of thinking of a methodology. The way of thinking delineates the view on a problem domain and provides the design principles the approach is based on, which are presented below.



#### 6.3.2.1 View on problem domain

The infrastructural approach to EDM determines the basic view on document-based problems. Instead of being limited to merely one organizational process of the organization, problems within the problem domain relate to a number of goal-oriented processes. The basic view on designing electronic document infrastructures involves these problems, always including both process control and document management. The relative importance of process control and document management are determined by the problems on hand.

- Basic view on problems in the problem domain**
- Instead of being limited to merely one process, problem situations are illustrative for other goal-oriented processes in the organization.
  - A problem situation includes both process control and document management.
  - The information content of documents and document exchange closely relates to an organization's process and output.

#### 6.3.2.2 Design principles

Based on the perspectives on organizational processes as presented in chapter 2, and the inductive cases presented in chapters 3 to 5, a number of design principles are proposed. These principles are presented below.

##### *Problem solving*

The previous section advocates taking document-based problems as a starting point for the design of an electronic document infrastructure. Consequently, designing an electronic document can be regarded as solving an ill-structured problem [Sol 1982]. Solving ill-structured problems requires an approach which addresses the complexity of the problem solving process. The problem solving literature describes several approaches to deal with ill-



structured problems [Simon 1973, Mitroff et.al. 1974, Ackoff 1978, Sol 1982, Bots 1989]. These approaches focus on finding a sufficient solution, instead of an optimal solution. The optimal solution can only be found when the conditions for problem solving are perfect (e.g. there is complete information and there are no assumptions to be made). Ill-structured problems lack perfect conditions for problem solving, making it impossible to identify the optimal solution. In that case, the solution-finding process is aimed at finding a sufficient solution. This is named procedural rationality. The procedural rationality will be applied to designing electronic document infrastructures, based on the problem solving cycle. With respect to the way of working in section 6.3.3, the latter will be elaborated on.

#### *Middle-out approach towards system design*

Designing a complex system requires a structured decomposition of the object to be designed, decomposing the envisioned system into smaller parts. This approach of 'gradual refinement' starts with a global view on the object to be designed. This will become increasingly clear during the refinement, finally ending in a detailed system design. This is in fact a 'top-down' approach towards systems design. Ackoff [1980] showed that a 'top-down' approach should be accompanied by a 'bottom-up' approach, since complex systems, such as organizations, represent more than its consisting parts. Synthesis views the item to be explained as a part of a larger whole, whereas analysis views items as a whole to be taken apart [p.217].

Chapter 2 argues that a thorough understanding of document use requires an understanding of the covering organizational process they are used in. Consequently, the starting point for the design of an electronic document infrastructure are organizational processes. An electronic document infrastructure, however, focuses on processes of which the course of action is difficult to predict (they are ill-structured). The methodology for designing electronic document infrastructures regards processes as the starting point for both a rough and a detailed design. The rough design contains the architecture of the infrastructure and the basics of process control and document management. The detailed design includes a document inventory and a list of document attributes. Figure 6.2 shows this line of reasoning, which in fact is 'middle out'. Naturally, the rough and the detailed design should be consistent. Consequently, one has to alternate between the rough and the detailed design.

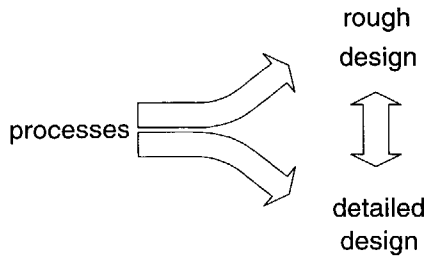


Figure 6.2 Middle-out system design approach towards the electronic document infrastructure

### *Principle of process control*

It is expected to be possible to formulate a general principle of process control which can be used for a number of process-related issues, such as budget control, time accounting by employees, etc. Such a principle will be applied to ill-structured processes in order to determine the dominant criteria to access documents. If no clear principle is used for process control in an organization, the first step in designing an electronic document infrastructure will be constructing it. This principle should fit ill-structured processes.

### *A participative design strategy*

The importance of user participation in systems design is well-known [Avison and Fitzgerald 1995]. User participation is also regarded highly important to the design of an electronic document infrastructure due to a number of reasons:

- The electronic document infrastructure will support users in manipulating and exchanging documents. Chapter 2 shows that documents are manipulated when activities are executed by (groups of) individuals. The way users can acquire access to electronic documents should fit the tasks they execute. Documents will be made accessible by using prevailing principles for process control. One has to determine to which amount the latter satisfies operational task execution, or whether it requires additional ways of making documents accessible.
- Document creators (i.e. users of the infrastructure) will play an important role in document registration. One has to determine the best way of document registration. For example, one has to decide on the moment of registration, prior to or after document creation, and the way of registration, whether it is processed automatically or on the initiative of the document creator.
- The relation between process control and document management needs to be explicit. For instance, when can the status of a document be

changed from active to passive? Should this be done automatically when the process status changes, or on the initiative of the user?

A participative strategy towards system design means that stakeholders should participate in all stages of the problem-solving cycle [see also Babeliowsky 1997]. In designing the rough and the detailed design, different interests play a role. For instance, considering the definitions of architectural standards and additional ways of making documents accessible, reveals two different areas of interest. The latter will be of great importance to users, whereas the first will be of great importance to IT management.

### 6.3.3 Way of working

The 'way of working' of a methodology structures the development of information systems [Sol 1982, Wijers et.al. 1992], which in this case refers to the electronic document infrastructure. The development of information systems is often considered solving an ill-structured problem [e.g. Sol 1982, Bots 1989, de Vreede 1995]. It is submitted that the development of an electronic document infrastructure is also an ill-structured problem. This is due to the interdependence between organizational processes using the infrastructure, the interdependence between processes and documents, the actors involved, and the many task needed to be carried out in order to develop the infrastructure.

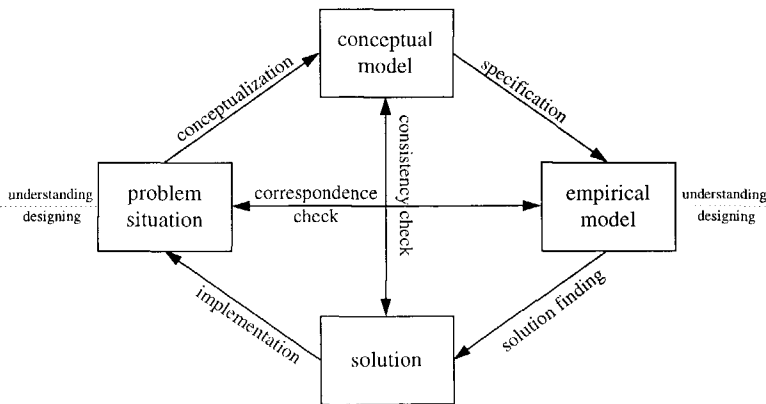


Figure 6.3 Problem solving cycle [after Mitroff et.al. 1974]

Figure 6.3 shows the problem solving cycle for ill-structured problems. This cycle represents the basics of solving ill-structured problems, which can be applied to different problem situations [e.g. Sol 1982, Meel 1994, Eijck 1996].

The way of working presented in this section is derived from the problem solving cycle.

The problem solving cycle includes six activities divided into an understanding and a designing phase. The first activity in the cycle represents the construction of a mental model, the conceptual model, which broadly expresses the problem situation and potential solutions. The conceptual model provides the problem solver with a vocabulary to describe the problem situation. The empirical model represents a detailed specification of the problem situation: it is an 'as is' model. The conceptual model is directed towards the second activity: specification of the problem situation. The empirical model is used to study the problem situation and consequently to generate possible solutions. During the process of finding a solution, the empirical model represents the problem situation. In order to determine the effects of the solution, the latter is translated into the empirical model, thereby transforming the empirical 'as is' model to an 'as could be' model. Comparing the effects of a number of 'as could be' models, results in a certain solution which might be implemented in 'real life'. The close correspondence of the empirical model with the problem situation is of great importance, since these are used in evaluating possible solutions. A possible solution has to be formulated in the vocabulary of the conceptual model. This is to be sure of its consistency with the conceptual model.

#### *Non-sequential execution of the problem solving cycle*

The problem solving cycle might suggest a sequential execution of activities. In practice, one will go through the problem solving cycle a number of times, executing several activities more than once. During the execution of a certain activity, one may encounter problems relating to a preceding activity. Solving such a problem will require re-executing the activity in question.

#### **6.3.3.1 Conceptualization**

During the conceptualization of the problem situation, the problem has to become clear. The output of the conceptualization is a conceptual model which delineates the problem situation and states the boundaries between a problem situation and its environment [Bots 1989, p.34]. The importance of problem delineation is illustrated in the DSP case and the Investigation Service case. Problems regarding process control are sometimes represented as documental problems, even though they involve a number of managerial aspects. During the conceptualization it has to become clear to which amount an electronic document infrastructure can contribute to solving the problems. This can be achieved either directly by being a tool for document management, or indirectly by enabling organizational change. It is

important to diagnose the problem situation from different angles in order to reduce the risk of making 'an error of the third kind' [Mitroff and Featheringhouse 1974], which means solving the wrong problem. Hence, the conceptual model should enable the designer to study the problem situation from different angles.

Bots [1989, p.34] also states that a conceptual model should provide insight into the objects that constitute the problem situation. Furthermore, the conceptual model should provide insight into the relation between these objects. Derived from the basic view towards problems in the problem domain, a conceptual model should include electronic documents and their use in processes. More precisely, the conceptual model should make clear how process control is implemented by the organization, according to which principle, and to which extent the status of a document is related to the process status. If there is no general principle in the organization used for process control, one should try to construct a specific principle. The modeling technique used to represent the conceptual model is discussed in section 6.3.4.2.

### **6.3.3.2 Specification and solution finding**

Figure 6.3 shows specification and solution finding as separate, sequential activities. During the specification, a conceptual model is transformed into an empirical model. Regarding solution finding, the empirical model is used for generating and evaluating alternative solutions to the problem situation. In specification and solution finding, the empirical model will be transformed from a descriptive ('as is') model to a prescriptive ('as could be') model. In this section, specification and solution finding are presented.

#### *Specification*

In the activity specification, the rich picture presented by the conceptual model, is reduced to an empirical model and substantiated with quantitative information [Checkland 1981]. In order to study the problem situation, it should be possible to experiment with the empirical model. Executable models, like a prototype or a simulation model, offer experimentation facilities [Weijers et.al. 1992]. In case the problem situation contains dynamics, these should be incorporated into the empirical model [Sol 1982, Bots 1989]. Avison and Fitzgerald [1995 p.77] summarize a number of situations in which prototyping is useful:

- the application area is not well-defined;
- the organization is not familiar with the technology (hardware, software, communications, designs, etc.) required for the application;
- the communication between analysts and users is not sufficient;

- the cost of rejection by users would be high. It is essential to ensure that the system's final version is based on a validated representation of users' needs.

Prototyping is also a way of encouraging user participation.

The design of an electronic document infrastructure includes a number of these aspects. An electronic document infrastructure supports a large number of organizational processes, to which a demonstration of the services provided by an electronic document infrastructure may be necessary. The electronic document infrastructure will integrate process control and document management. These aspects, as well as the technology used for integration, may be new to an organization. EDM is expected to be new to users, making them more aware of their responsibilities towards electronic documents. A prototype can be implemented to communicate with users regarding the effects of an electronic document infrastructure on their tasks.

More precisely, a prototype can be used to study a number of design decisions, such as:

- Does the registration of electronic documents occur during or after the author's creation of the document, and by whom, the author or the records keeping unit?
- What will the basic structure be in which electronic documents are presented to users?
- Which document attributes is one obligated to enter or may be skipped when registering an electronic document?
- How can users search for an electronic document?

A prototype is useful when answering these kinds of questions, enabling involved parties to study the consequences, and comment on proposed solutions.

Prototyping is useful to study both the functions of the electronic document infrastructure and the feasibility of implementing the electronic document infrastructure. The first relates to the detailed design, whereas the latter relates to the rough design (see figure 6.2). By building a prototype, one becomes aware of the possibilities of the design tool and the demands towards the technical architecture. For instance, the possibility of building interfaces with general and dedicated applications. In order to be able to change the prototype into an accurate projection of the final system, one has to build a number of these interfaces. This is an accurate way of testing the integration possibilities. This is particularly important in case the prototyping tool is more or less similar to the tool used to build the final system. When

testing the results of the prototyping in a pilot-project, both the feasibility and the functions are checked extensively.

### *Solution finding*

Solution finding includes the generation and evaluation of ideas. Various techniques can be used to generate alternatives. Van Meel [1994, p.117 a.o.] gives a nice overview. These alternatives commonly 'trigger' creative processes with participants involved in problem solving. These creative processes are essential to the generation of alternatives. The empirical model is used to synchronize the perception of participants of the problem situation. Furthermore, the empirical model is implemented to stimulate the creative process. Prototyping can also be used to stimulate creative processes. This can merely be executed on the condition of the possibility to illustrate the effects of a certain idea on the electronic document infrastructure.

The choice of a certain alternative should be based on a thorough analysis. Prior to the evaluation of alternatives, criteria used for evaluation should be formulated. Four types of criteria are distinguished:

- Criteria relating to the conformation of the electronic document infrastructure to the information infrastructure and its consisting parts (e.g. application infrastructure, hardware infrastructure, communication infrastructure, organization infrastructure and structured data infrastructure), and the standards used.
- Criteria relating to the information content of documents.
- Criteria relating to the balance of the infrastructure's universal use and optimal process support.
- Criteria to ensure that the solution chosen will be long-lasting and fail-proof.

The empirical 'as could be' model, implemented in a prototype, enables communication with future users of the EDM. This provides them with insight into the effects of alternatives to the organizational goal-oriented processes in which they operate. The system designer should translate the comments of users into the criteria defined. Additionally, the system designer should write the final evaluation report, comparing the alternatives according to the criteria defined.

The design of an electronic document infrastructure will have an impact on every goal-oriented process in the organization. This should be taken into account when generating and evaluating alternative solutions to the problem situation. During this phase, the balance of universal use of the infrastructure

and optimal process support occurs. For instance, this balancing occurs by defining functions of the infrastructure, attributes which need to be registered, and procedures for document manipulation. With respect to goal-oriented processes, the process of balancing requires the studying of proposed characteristics of the infrastructure. Hence, the prototype of a certain solution should be evaluated from different angles, which represent the variety of organizational goal-oriented processes. Consequently, different types of future users (e.g. performing operational or managerial tasks) should be involved in the generation and evaluation of alternative solutions.

The phase involving solution finding, will result in a rough and a detailed design, which are to be consistent with each other. Figure 6.4 shows the issues to be addressed in the rough and the detailed design.

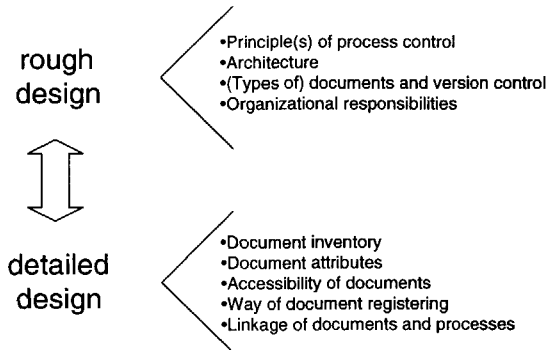


Figure 6.4 Issues to be addressed at different design levels

### 6.3.3.3 Implementation

The final activity of the problem solving cycle is implementation. This activity starts after the design phase is ended. The objective of this research project is to build a theory involving the design of electronic document infrastructures (see section 2.4). The implementation phase is not within the scope of this research. It is mentioned, however, that one should be aware of the initial problems one tries to solve. In case one tries to solve these problems with an electronic document infrastructure, one should keep the 'returning to the initial problem cycle' of chapters 4 and 5 in mind. The possible objectives of implementing an electronic document infrastructure, ranging from enabling organizational change to integrating supporting tools for document management and process control, determine the focus and the structure of the implementation project.



**6.3.3.4 Participation of stakeholders in the problem solving cycle**

It is already mentioned that the field of information systems is familiar with user participation. In each phase of the problem solving cycle, the participation of stakeholders is of great importance. During the problem solving cycle, stakeholders should become involved in problem solving activities and be asked for their opinions and ideas. The following stakeholders are distinguished:

- general management;
- document users, e.g. authors, document creators, etc.
- records keeping, e.g. people performing document management tasks;

Besides these stakeholders, the IT department (e.g. people responsible for the organization’s IT) is also distinguished.

Figure 6.5 shows the role of stakeholders during the problem solving cycle, which is discussed below.

activity in the problem solving cycle	rough design	detailed design
conceptualization	<ul style="list-style-type: none"> <li>• general management is problem owner</li> </ul>	<ul style="list-style-type: none"> <li>• document users and the records keeping unit supply information</li> </ul>
specification and solution finding	<ul style="list-style-type: none"> <li>• general management decides regarding the design</li> <li>• IT management approves of the architecture</li> </ul>	<ul style="list-style-type: none"> <li>• document users and the records keeping unit approves of the detailed design</li> </ul>

*Figure 6.5 Role of stakeholders in the problem solving cycle*

The image of the records keeping unit in organizations is rather stuffy. The electronic document infrastructure has to be prevented from being perceived similarly. The organization’s management can contribute by stressing the importance of document management to process control. Furthermore, derived from this, the importance of an electronic document infrastructure to the organization should be stressed. During the process of problem solving, the general management should actively participate in defining and conceptualizing the problem situation, as well as participating in the phase of solution finding. The general management should also approve of the final solution, which will be implemented.

A number of authors, being document creators, should take part in the conceptualization and solution finding. The authors will be the future users of the infrastructure and, accordingly, should influence both the problem definition and the design of the infrastructure. During the specification of the conceptual model, they will be asked to supply information regarding document use. During the implementation phase, the authors will attend

courses and should participate in adding existing electronic documents to the infrastructure. Consequently, authors are involved in each phase of the problem solving cycle, playing different roles.

The records keeping unit will represent the archival approach to document management as described in section 1.2.1. The records keeping unit will be concerned with the conceptualization and specification phase in supplying information regarding document use. During the solution finding phase, the records keeping unit will be concerned with the functions of the infrastructure concerning the accessibility of documents and document management. They are likely to be involved in the implementation on an operational level, e.g. user support and adding existing documents to the infrastructure.

Implementing an electronic document infrastructure will have impact on an organization's IT. From a technological perspective, electronic documents of several applications are structured within one technological environment. This will complicate IT management, whereas applications used to operate separately, will be integrated with other tools. IT management should support conclusions regarding the technological feasibility of an electronic document infrastructure design. Given the fact that a chosen solution strongly relates to the problem definition, IT management should participate in both the conceptualization of the problem and the generation of solutions.

#### *Communicating with different kinds of users*

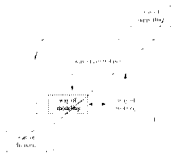
The communication of the design team should be tuned to the interests of the stakeholders. To the general management, one should stress the improvement of process control, the ability to generate management information regarding document use, and possible efficiency improvements. In case documents in the organization have a high evidential value, this point should also be stressed to the general management.

The support to the workplace should be emphasized to document users, which enables them to acquire practically all documents electronically, without leaving the workplace. Furthermore, a reduction of the number of missing documents should be stressed. It is already mentioned that document users are expected to focus on the information content of documents. This, however, does not imply that no time is spent on document management. The implementation of an electronic document infrastructure is expected to reduce the time spent. This is due to the document user's responsibility towards document management tasks, such as registering self-created documents.

The task of the records keeping unit will change as a result of the implementation of an electronic document infrastructure. Routine tasks, like registering documents and document delivery, will become less time-consuming. Document management tasks concerning the information content, on the other hand, are expected to become increasingly important. In due time, records keeping might evolve from document management to information or knowledge management. These issues should be emphasized to the records keeping unit, in order to overcome resistance as a result of the expected decrease of workload.

### 6.3.4 Way of modeling

The 'way of modeling' of a methodology joins the concepts used to create models of the problem domain. This section describes these concepts and their application to models. According to the working method, two kinds of models are distinguished: a conceptual model and an empirical model. These models are presented in separate sections. Prior to the discussion of these models, their relationship and the concepts used will be presented.



#### 6.3.4.1 Modeling concepts and relationship of models

The document-based processes of the case studies presented in chapters 3 to 5 are described using the concepts presented in section 2.3. The findings of the IRS case are used to reduce the problem domain to document-based goal-oriented processes. The concepts presented in chapter 2 were formulated, whereas the problem domain was not limited to goal-oriented processes. Hence, it is necessary to reformulate the concepts of chapter 2 and tune them more closely to goal-oriented processes, using the experiences of the Investigation Service case and the DSP case.

Models employed to study the problem domain should comply with the basic view on the problem domain. Models constructed to study organizations encountering document management problems when executing goal-oriented document-based processes, should be illustrative for several goal-oriented processes executed by the organization. Furthermore, these models should include both process control and document use, and link documents to processes. This implies that models should include both the process part and the document part of a problem situation. The following sections describe the modeling concepts used to study these parts.

#### *Concepts to study the process part of the problem situation*

The view on organizational processes as presented in section 2.2, distinguishes between the organizational chain, the process structure, and

the activity structure. The goal-oriented processes presented in chapters 4 and 5 were studied similarly.

The Investigation Service case and the DSP case showed that, due to the occurring exceptions, it is not possible to build an activity structure for goal-oriented processes, completely representing the process. These cases also showed that the need for process control is limited to gathering information regarding the status of the process, identifying its current phase. To gather this information, it is necessary to divide the process into phases complying with process control and to name the possible statuses of the process. Compared with a list of possible statuses, a complete model of the process has no additional value to process control.

Figure 6.6 shows the modeling concepts of the process part of the problem situation. It shows a process-tree of an organization, representing the structure of goal-oriented processes and their matching characteristics. Of each goal-oriented process, only three characteristics are taken into account:

- the possible statuses of the process used for process control;
- the volume of the process, representing the frequency of the execution in one year;
- the types of documents used in the process. The types of documents link the document part to the process part of the problem situation.

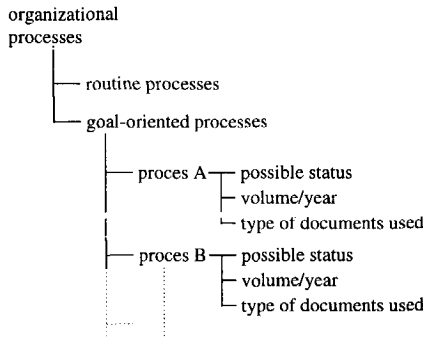


Figure 6.6 Process modeling concepts

Chapter 4 shows the basic structure of document processing (figure 4.11). This structure is expected to apply to each goal-oriented process.

*Concepts to study the document part of the problem situation*

Besides describing the document dimension which should be taken into account when analyzing document-based processes, section 2.1 provides a working definition of documents.

The Investigation Service case and the DSP case showed that several types of information are used simultaneously:

- information in structured databases;
- unstructured information on word-processing files, spreadsheet files, etc.;
- information on hardcopies.

Each of these types of information fit in the working definition of documents given in section 2.1, whereas the electronic document infrastructure focuses on electronic documents like word-processing files, spreadsheet files, etc. Hence, the working definition of documents is reformulated to exclude structured databases.

**Electronic document** An electronic document is a set of information, regardless of its carries, which is not structured in a database.

Examples of electronic documents are image files, word-processing files, spreadsheet files, desktop publishing files, etc. This definition does not refer to the information content of documents. Consequently, it allows an electronic document to have any kind of format.

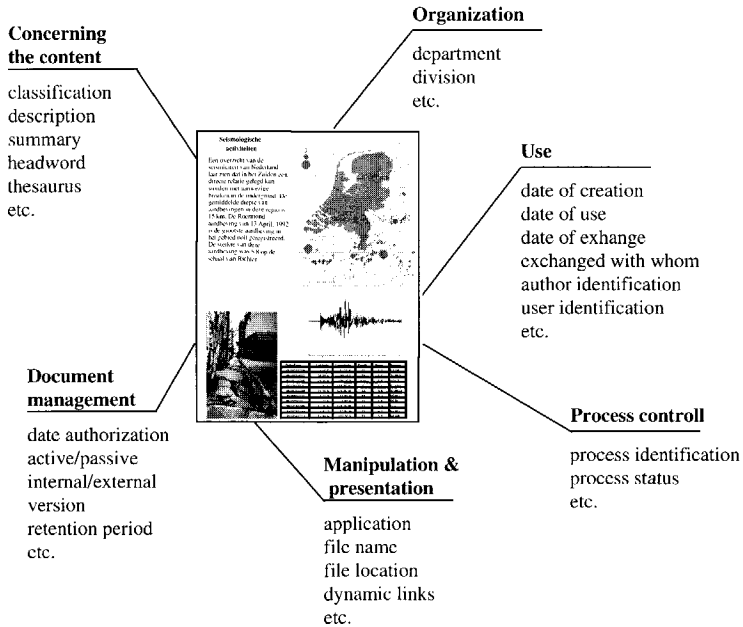


Figure 6.7 Attributes of electronic documents

The document dimensions presented in section 2.1 are transformed to document attributes for electronic documents. Figure 6.7 shows the categories regarding attributes and lists a number of examples for each category. Different kinds of documents require different kinds of attributes. Attributes concerning a document's information content, for example, will depend on the kind of document. The attributes of a memo will be less comprehensive compared to the attributes of a final report. Consequently, electronic documents should be categorized according to the applicable attributes.

The Investigation Service case and the DSP case showed that it was impossible to identify the way documents are manipulated in goal-oriented processes. The application used for creating an electronic document determines the possibilities of manipulation and presentation. Hence, the manipulation dimension can be narrowed down to the application used to create an electronic document. This application also determines the possibilities for presentation. Consequently, the presentation dimension can also be narrowed down to some attributes concerning the application.

From an infrastructural point of view, the information dimension, referring to the structure of information, is not of importance. The information content is exclusively important to classify documents in order to make them accessible. Figure 6.8 shows the classification of electronic documents to document types from which the document attributes should be identified.

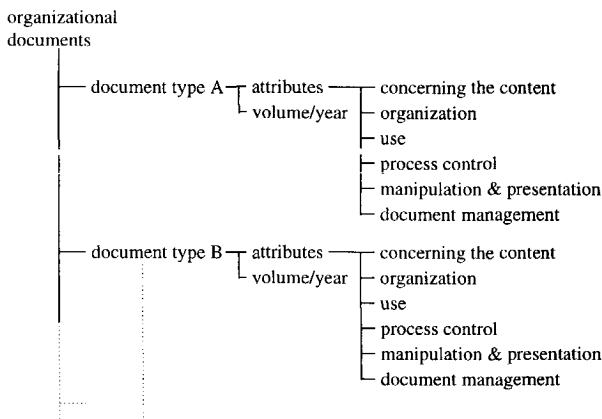


Figure 6.8 Document modeling concepts

Attributes concerning document exchange are grouped with attributes concerning document use (e.g. date of creation, author, etc.). The group of

attributes named 'process control' includes attributes which identify the process the document relates to. The attributes in the group named 'organization' link documents to organizational units.

Archival principles, like provenance and respect for original order (see section 1.2.1), will be translated into attributes like 'author identification' and 'date of creation'.

*Relationship of models*

The relationship between the models used in the problem solving cycle is determined by the way of working. Figure 6.9 shows this relationship. During each phase of the problem solving cycle, different aspect models are used to highlight specific model characteristics.

The conceptual model includes two aspect models: the process tree and the document tree. The process tree represents the organizational processes which are part of the problem situation. The document tree structures the variety of documents used in these processes. These models are called trees because instead of structuring a specific process or document, they provide an overview of the processes and documents on an organizational level.

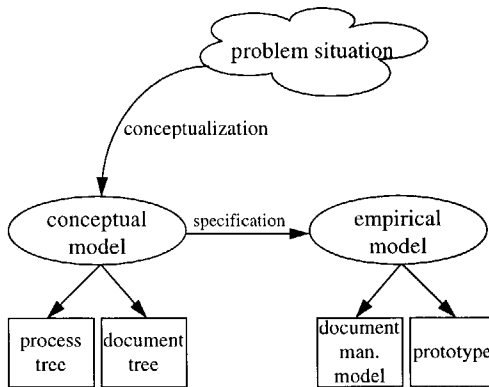


Figure 6.9 Relationship between models

The empirical model includes a document management model and a prototype. The document management model shows the way EDM is implemented organizationally. The prototype, used for solution finding, shows how supporting tools can be designed. First, a certain solution is opted for. Second, it needs to be elaborated on. The latter needs to be done in order to build the supporting tools of the electronic document infrastructure. In other words: the rough and the detailed design have to be

completed. The following sections present the models mentioned in figure 6.9. Section 6.3.4.4 discusses the completion of the design.

### 6.3.4.2 Conceptual model

A conceptual model provides an abstract representation of the problem situation [Aerts et.al. 1991]. The empirical model describes the problem situation in detail. The goal of the conceptual model is to represent and restrict the problem situation. The conceptual model holds both the process and the document part of the problem situation, each presented in a model: the process tree and the document tree.

#### Process tree

The problem situation is restricted by summarizing its organizational goal-oriented processes. Of each process, the principle used for process control is to be detailed in variables and criteria. The process tree lists processes, grouped according to these variables and criteria. This provides insight into the variety of process control options existing in the problem situation. The documents used in a certain process should be grouped into different types of documents. Hence, a process tree includes the following elements:

- a list of ad-hoc processes;
- a list of types of documents;
- a list of variables and criteria for process control.

Figure 6.10 gives an example of a process tree using the data of the DSP case. The process structure is derived from the structure used for financial accounting.

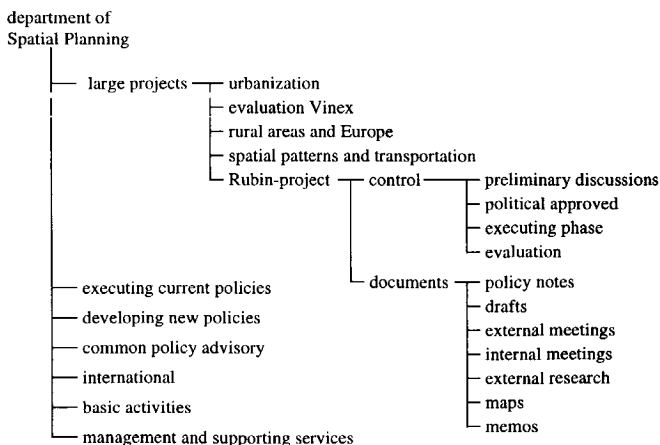


Figure 6.10 Example of a process tree using the data of the DSP case



### Document tree

Electronic documents are used in processes. Regarding these documents, a number of aspects are registered; the sender, the employee who deals with the matter, when it is due, etc. Depending on the type of document, different aspects will be registered, which means that, different attributes are of importance to the document. Regarding each process of the problem situation, the document tree lists the documents used and specifies which information is registered and how. Figure 6.11 gives an example of the document tree, again using the data of the DSP case. Figure 6.11 relates to figure 6.10.

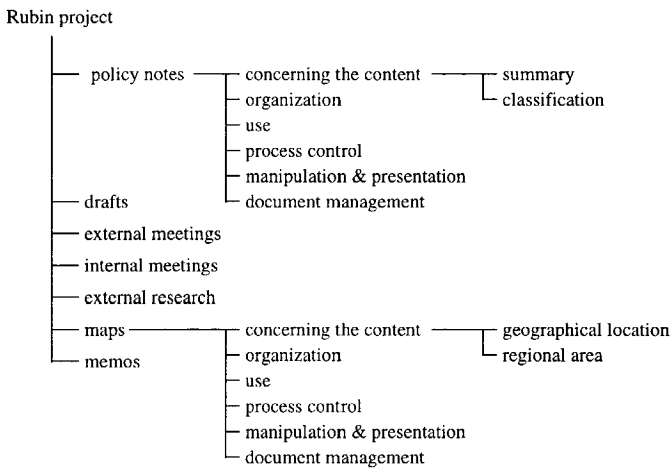


Figure 6.11 Example of a document tree using the data of the DSP case

#### 6.3.4.3 Empirical model

The empirical model represents the 'as is' and 'as could be' of a problem situation. The models which represent the 'as is' and 'as could be', use the same modeling technique. The empirical model holds two aspect models, a document management model and a prototype. The document management model elaborates on the conceptual model, adding quantitative information regarding the problem situation and presenting document management processes. The prototype is an executable model used to study alternatives, to communicate with stakeholders, and to test the feasibility of building the electronic document infrastructure using the chosen design tool. Below, the document management model and the prototype are described more closely.

*Document management model*

Starting point for the document management model is the combination of the process tree and the document tree. The document management model adds the following quantitative information to these trees:

- the number of times a process is executed;
- the number of electronic documents involved;
- the number of documents exchanged externally.

This quantitative information will be used in solution finding. Furthermore, it will be used in completing the design, to estimate the required capacity of the infrastructure, such as the network capacity and the capacity of the document data base.

The document management model also describes the organizational aspects of EDM. In other words, concerning electronic document, it describes the responsibilities of organizational functions such as document creators (e.g. authors), the records keeping unit, IT management, and general management. The description of these responsibilities can be shaped like a process diagram for routine document management tasks, or an enumerative list of actions. The document management model should explicitly pay attention to the following aspects of document management:

- scanning paper documents;
- registering documents;
- making documents accessible;
- retention of documents;
- maintaining the scan list;
- maintaining the process and document structure used for registering;
- maintaining the accessibility of documents;
- system management of the used IT tools;
- user support.

*Prototype*

A prototype will reflect the future functions of the electronic document infrastructure. Section 6.3.3.2 lists a number of design questions which may be answered by using a prototype. In order to answer these questions, a prototype should represent the following functions of the electronic document infrastructure:

- document registration;
- basic structure of making documents accessible;
- version control of documents, and if relevant, a linkage between document version and process status;
- one or more interfaces with a general application, and if relevant, with a dedicated application.

A prototype can be built by using special tools which facilitate the quick design of screens and reports. It can also be built by using the programming language in which the final system will be produced. This enables the re-use of designs composed to make the prototype. The choice of a certain environment in which the prototype is implemented, will depend on an organization's technological standards and experience with prototyping tools.

#### **6.3.4.4 Completing the design**

The models described until now, do not include all aspects of the rough and the detailed design. In order to complete these designs, version control, the IT architecture, and the functions of the supporting tool have to be described into more details.

##### *Version control*

Documents can have two different kinds of version control, namely 'edit version' and 'authorized version'. Edit version refers to an update of the document version each time a part of the document changes. This kind of version control can be implemented automatically and may result in a large number of versions. This merely occurs in case a document is used and re-used for a longer period. In 'authorized version', the author has to decide on an update of the document's version. This is usually done in case something basic changes. The document tree has to be completed, identifying which kind of version control is required.

##### *IT architecture*

The architecture represents the framework of the electronic document infrastructure (see also section 6.2). An architecture sets technological, informational and procedural corporate standards.

Concerning technology, the architecture shows the specific hardware and software tools employed to implement the functionality of the electronic document infrastructure. Figure 6.12 provides an example of an architecture. Figure 6.12 and 6.13 show which functions will be implemented by which part of the architecture. Implementing an electronic document infrastructure requires the identification of software products which fit the architecture and comply with the functions required. For example, the selection of a database supporting the electronic repository, which has interfaces with dedicated applications and an EDM tool. Another example is the selection of an EDM tool which supports the organization's applications used for document manipulation. When selecting certain tools it is important to comply with organizational standards, to choose tools which are used widespread, and appear to be long-lasting and fail-proof.

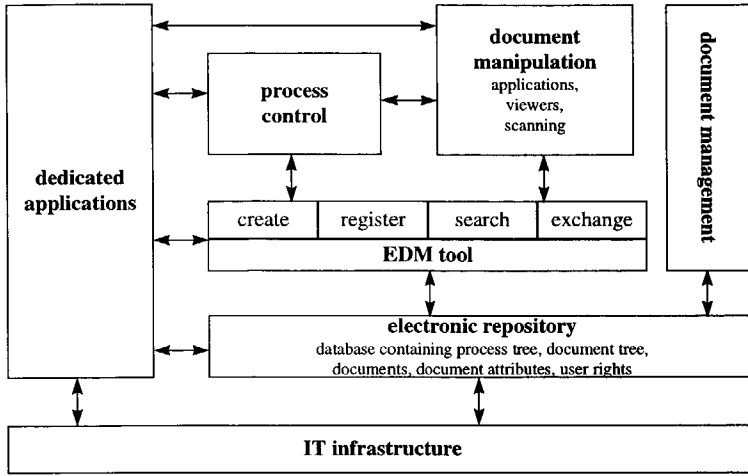


Figure 6.12 An example of an architecture

The informational part of the EDM (e.g. how to make electronic documents accessible) is represented in the prototype, whereas the procedural part is represented in the document management model. The architecture identifies which elements of these models are applicable to the whole organization and which elements may be tuned to a local level. In other words, with respect to the informational and procedural parts of the chosen solution, the architecture identifies to what level organizational units can freely implement EDM tools.

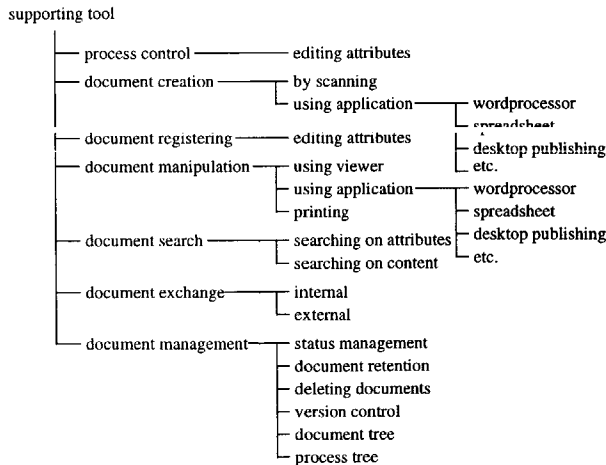


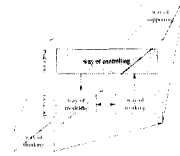
Figure 6.13 An example of a structured list of functions of a supporting tool

*Functions of a supporting tool*

Except for the prototype, the models presented until now have a relatively high level of abstraction. Furthermore, they focus on a certain aspect of the electronic document infrastructure. In order to implement a supporting tool, the functions a similar tool need to be specified. Hence, a structured list of functions, shown in figure 6.13, needs to be completed. The structure of the list is derived from the basic structure of document processing, presented in section 4.3.2, and the life cycle of documents.

**6.3.5 Way of controlling**

The 'way of controlling' of a methodology describes the design project in terms of checkpoints, documentation, decisions, and time management [Turner 1980, Turner et.al. 1989]. The way of controlling includes planning and plan evaluation. The project is established by indicating the interaction of the various persons and groups. Furthermore, the manner in which generally limited resources should be employed and allocated, needs to be indicated. Hence, the way of controlling represents the managerial aspects of executing the problem solving cycle.



The way of controlling should assure the final design of the electronic document infrastructure to offer a sufficient solution to the problem situation (see also section 6.3.2.2). Given the nature of the electronic document infrastructure, the way of controlling should stimulate user participation and allow the discussion involving important design decisions in an open atmosphere.

Working towards a sufficient solution implies gaining approval of different stakeholders (e.g. authors, the records keeping unit, management, etc.) of a proposed solution. In order to reach this approval, one will probably execute the problem solving cycle non-sequentially, as argued in the way of working. This complicates project management; activities will be difficult to plan. Hence, instead of focusing on executing the problem cycle according to a time schedule, one should focus on executing the problem cycle according to the right procedures. In order to achieve this, at the start of the project, stakeholders should be informed about the procedures according to which certain design decisions are made. For instance, which stakeholders are asked to comment on problem delineation in terms of goal-oriented processes and which stakeholders are asked to comment on the prototype.

Despite the non-sequential way of executing the problem solving cycle, traditional project management is of importance. The methodology for the design of an electronic document infrastructure allows the use of any kind of project management approach. One should, for instance, define checkpoints which have to be substantiated using reports approved by the stakeholders.

#### **6.4 Discussion**

The electronic document infrastructure offers support to goal-oriented processes on an infrastructural level. The design approach does justice to the infrastructural character by modeling at an organizational level, searching for possibilities to support a large number of goal-oriented processes. This requires a list of organizational processes and documents.

Except for the making documents accessible by means of classifications, the design approach pays little attention to the information content of documents. Using SGML or HTML, documents can not be made accessible on an infrastructural level. This is due to the close relation between the information content of documents and the process they are used in. Documents brought into the electronic document infrastructure can have any format. On an infrastructural level, the only aspect registered is the application by which a document is manipulated. Consequently, it is possible to use SGML or HTML as a document format in the electronic document infrastructure.

According to the delineation of the research area, the design approach strongly focuses on active documents. For long term retention, electronic documents which are part of the electronic document infrastructure, can easily be transferred to an electronic repository. This removes the electronic documents from the active electronic document infrastructure and replaces them into an electronic archive. When this happens, archival issues like the evidential value of documents, become very important to determine the retention period. It is expected that one can deal with archival issues on the level of document types. This enables the automatic deletion of documents, which are due to be deleted.

## 7. Case 4: Applying the design approach

The Project Organization High Speed Line South (HSL) is responsible for preparing political decision making regarding the high speed railway in the Netherlands. Furthermore, HSL is responsible for designing and implementing the railway. In these processes, a large number of documents are created within a wide variety: drawings, maps, output of calculations, different kinds of memos, reports, notes, etc. Besides an operating high speed railway, HSL also has to deliver appropriate documentation needed for maintenance. Consequently, document management is very important to HSL.

This chapter presents the design of an electronic document infrastructure for the HSL. The design of the electronic document infrastructure is tested in a pilot project. The designing and testing are presented as far as the evaluation of the pilot project. Based on the latter, the general management of HSL decided to implement the electronic document infrastructure company-wide.

The author participated in the design and evaluation of the electronic document infrastructure. This action research was conducted from April 1996 until April 1997. Appendix A.4 describes the project structure used for designing and testing the infrastructure in combination with involved external organizations.

### 7.1 The Project Organization High Speed Line South

#### *Mission and organizational setting*

Both the Ministry of Transport and Public Works, and the Ministry of Housing, Spatial Planning and the Environment, are responsible for the realization of the high speed railway. The Ministry of Transport and Public Works supervises the project management. In order to support the design and implementation of the railway, a new organization is established: the Project Organization High Speed Line South (HSL). A number of organizations are asked to participate in HSL, of which RIB<sup>30</sup>, Holland Railconsult and DHV are the most important. RIB is responsible for composing the railway demands and managing the project. After realizing the railway, it will be handed over for maintenance to RIB. The headquarters of HSL are in Den Haag, with other offices kept in Utrecht, Den Bosch and

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<sup>30</sup> After its Dutch abbreviation, NS Railinfrabeheer. RIB is responsible for the exploitation of the railways in the Netherlands.

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Rotterdam. The electronic document infrastructure is implemented in the Utrecht office. The Utrecht office is responsible for the design and implementation of the railway, while the other offices focus on regional and local decision making. People working for HSLs are mostly hired from RIB, DHV and Holland Railconsult. The number of people working for HSLs strongly increased during the progress of decision making. At the start of this case study, approximately 130 people were employed by HSLs Utrecht. After the decision to implement the electronic document infrastructure was made, this number increased to almost 350 people.

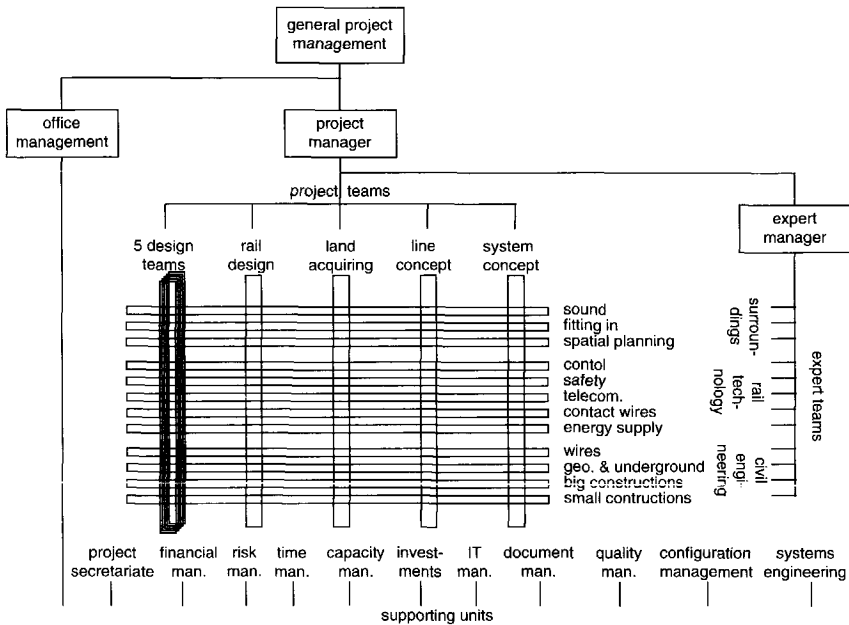


Figure 7.1 HSLs matrix organization [after Corstiens et al 1996, p.12]

The tasks of HSLs relate to decision making, design and implementation. HSLs organizes the preparation of local, regional and national decision making regarding the railway. For example, preparing a number of alternative designs with respect to the locations of the railway and railroad bridges and tunnels. The railway design and political decision making are linked. The output of the design process is used in political decision making, while decision making generates a new demand for the design. The interaction between decision making and designing results in a rough design. This rough design will only become final after a final decision is made, and one can start with realizing the project plans. In outlines, realization includes



detailing the rough design, specification, composing work drawings, putting out to tender, allotment, and controlling the implementation.

The realization of the high speed railway is a complex project, requiring a large number of different professional abilities. In the HSL organization, these abilities are grouped in so-called project teams and expert teams. These are organized in a matrix organization, shown in figure 7.1. The five design teams (DT) are responsible for the design of a certain part of the high speed line. The teams named System Concept and Line Concept implement the integration of the designs made by the design teams. In case one of these teams requires certain professional abilities, they apply to one or more of the expert teams. The expert teams are shown on the vertical axis of figure 7.1. Office management is responsible for both quality management and supporting the design and expert teams. The horizontal axis of figure 7.1 represents the supporting units which are part of the office management.

#### *Initial problem description*

In designing and implementing the railway, a large amount of information is created by HSL, using a large number of different IT tools: from regular office applications to dedicated CAD and calculation applications. HSL is aware of the importance of managing this electronic information. This awareness exists on the management level, derived from the initial responsibility to deliver not only a railway but also appropriate documentation. Secondly, the awareness exists on the operational level, where the disadvantages of a lack of document management lead to discussions about the status of documents and drafts. In the worst case this may result in redesigning a certain part.

In order to co-ordinate the work of the design and expert teams, information is exchanged. A design of a certain object or element created by one team is re-used by one or more other teams. Keeping in mind the complexity of the design object and the interference of the design and decision making processes, one will understand that a design may change over time. Teams using a changed design will have to be informed about these changes. Not informing these teams may lead to an inconsistency in the final design. Consequently, one has to keep track of document dispersion, enabling the tracking to trace re-used designs. Based on this thought, HSL's management concluded that the quality of the final railway design is strongly influenced by the way information is being handled. Derived from this, quality management was asked to implement document management in order to assure the management of each design document in the HSL organization.

Given the fact that document management has to apply to each goal-oriented process, HSLs decided to implement an electronic document infrastructure. The latter is designed according to the design approach presented in chapter 6. The following section is structured similarly, each subsection dedicated to one phase of the problem solving cycle.

## **7.2 Designing the electronic document infrastructure**

### **7.2.1 Conceptualization of the problem situation**

#### *Basic structure of the railway design process and process control*

Organizational processes of HSLs are based on internal clients and orders. A team manager accepts an order and attends to the execution. Examples of an order are: composing a design for a section or calculating noise barriers. The order is processed by a team and will always result in some kind of final report or drawing: the output of the process. The internal client is responsible for the acceptance of the output. The advantage of this way of working is a clear customer - provider relationship, enabling cost accounting. A team manager is more or less autonomous in the way the order is processed, as long as quality standards are met. A team manager assigns the order to one or more team members and instructs them in executing the order. Team members operate like one unit, co-ordinating their activities by means of standardization of skills and mutual adjustment. Consequently, the information exchange within one team is mostly informal, while the information exchange between different teams is formalized by an internal contract.

The design process is goal-oriented, which is difficult to predict in terms of a detailed sequence of actions. The basic structure of the design process is shaped by the use of the internal contract, in which the output or the goal of the design process is clearly specified in terms of design demands.

HSLs uses a so-called 'object tree' in which the railway infrastructure is divided into its consisting parts. HSLs also uses a structured list of so-called 'control units'. A control unit is in fact a description of a work package. The list of control units structures the (design) activities needed to be carried out in order to realize the objects of the object tree. A control unit always relates to one or more objects, while an object always relates to one or more control units. Consequently, the relationship between control units and objects is n:m. Control units are used for work assignment, using the order concept. Each design activity executed therefore relates to one or more control units.

Control units are also used to monitor the progress of design activities, and to ascribe costs to, both in time and in money. It can be concluded that 'control units' is the dominant principle used for process control. Control units and objects are defined by a team named 'Line Concepts'.

*Organizational processes and document use*

The organizational processes of HSLs are structured in the list of control units. Figure 7.2 shows a part of this list which, using the vocabulary of the proposed design approach, is in fact a process tree. Each control unit has a clear starting date. Figure 7.2 also shows the numbers used for cost accounting. Due to the current phase of the railway design process, no control units are finished, which explains why the last column of figure 7.2 is empty.

Project Doelgroep 4					
Wutour Snijders					
Bereikingsaanbieder	Nummer	Bestingsnummer	Verantw/nummer	gescand op	gerekte op
Beaanroefingsprocedures vak 4.1	4A5	J1000.04.A52	1804A52		
Archeologisch onderzoek deeltraac 4	4BA	J1000.04.BA2	1804BA2	30 mei '96	
Bodemonderzoek deeltraac 4	4BB	J1000.04.BB2	1804BB2	30 mei '96	
Geotechnisch onderzoek deeltraac 4	4BG	J1000.04.BG2	1804BG2	30 mei '96	
Kunsthewken klein, vak 4.2	4D2	J1000.04.D22	1804D22	30 mei '96	
Kunsthewken klein, vak 4.3	4D3	J1000.04.D32	1804D32	30 mei '96	
Kunsthewken middel, vak 4.1	4E1	J1000.04.E12	1804E12	30 mei '96	
Kunsthewken middel, vak 4.2	4E2	J1000.04.E22	1804E22	30 mei '96	
Kunsthewken middel, vak 4.3	4E3	J1000.04.E32	1804E32	30 mei '96	
Kunsthewken middel, vak 4.4	4E4	J1000.04.E42	1804E42	30 mei '96	
Gebuidw. maatregelen, vak 4.1	4G1	J1000.04.G12	1804G12	30 mei '96	
Gebuidw. maatregelen, vak 4.2	4G2	J1000.04.G22	1804G22	30 mei '96	
Gebuidw. maatregelen, vak 4.3	4G3	J1000.04.G32	1804G32	30 mei '96	
Gebuidw. maatregelen, vak 4.4	4G4	J1000.04.G42	1804G42	30 mei '96	
Brug Hollandsch Diep (HD) algemeen	4HA	J1000.04.HA2	1804HA2	30 mei '96	
HD bovenbouw	4HB	J1000.04.HB2	1804HB2	30 januari '97	
HD onderbouw	4HD	J1000.04.HD2	1804HD2	30 mei '96	
HD asrieg / montage	4HG	J1000.04.HG2	1804HG2	30 mei '96	
HD volwervelrigger	4HJ	J1000.04.HJ2	1804HJ2	30 mei '96	
HD bogen	4HK	J1000.04.HK2	1804HK2	30 mei '96	
HD referentievariant	4HL	J1000.04.HL2	1804HL2	30 mei '96	
Inpassingsplan vak 4.1	4I1	J1000.04.I12	1804I12	30 mei '96	
Inpassingsplan vak 4.2	4I2	J1000.04.I22	1804I22	30 mei '96	
Inpassingsplan vak 4.3	4I3	J1000.04.I32	1804I32	30 mei '96	
Inpassingsplan vak 4.4	4I4	J1000.04.I42	1804I42	30 mei '96	
Compensatieplan deeltraac 4	4I5	J1000.04.I52	1804I52	30 mei '96	
Kunsthewken groot, vak 4.1	4K1	J1000.04.K12	1804K12	30 mei '96	
Kunsthewken groot, vak 4.3	4K3	J1000.04.K32	1804K32	30 mei '96	
Verlegde kolbels en ladingen deeltraac 4	4L1	J1000.04.L12	1804L12	30 mei '96	
Tunnel Oude Meuse (OM) algemeen	4NA	J1000.04.NA2	1804NA2	30 mei '96	
OM fundatie	4NC	J1000.04.NC2	1804NC2	30 mei '96	
OM bouwput/subweringsconstructies	4ND	J1000.04.ND2	1804ND2	30 mei '96	
OM toerften / open balken	4NE	J1000.04.NE2	1804NE2	30 mei '96	
OM cut- en coverdeel	4NF	J1000.04.NF2	1804NF2	30 mei '96	
OM afzinkdeel / aquaduct	4NG	J1000.04.NG2	1804NG2	30 mei '96	
OM kruisende infrastructuur	4NH	J1000.04.NH2	1804NH2	30 mei '96	
OM tunnels Technische installaties	4NJ	J1000.04.NJ2	1804NJ2	30 mei '96	
Projectmanagement, coördin. kostenrekening	4P1	J1000.04.P12	1804P12	30 mei '96	
Spoorontwerp deeltraac 4	4S1	J1000.04.S12	1804S12	30 mei '96	
Grondplan & ontweringsaankeningen	4T1	J1000.04.T12	1804T12	12 dec. '96	
Tunnel Dordtsche Kij (DK) algemeen	4TA	J1000.04.TA2	1804TA2	30 mei '96	
DK fundatie	4TC	J1000.04.TC2	1804TC2	30 mei '96	
DK bouwput/subweringsconstructies	4TD	J1000.04.TD2	1804TD2	30 mei '96	
DK toerften / open balken	4TE	J1000.04.TE2	1804TE2	30 mei '96	
DK cut- en coverdeel	4TF	J1000.04.TF2	1804TF2	30 mei '96	
DK afzinkdeel / aquaduct	4TG	J1000.04.TG2	1804TG2	30 mei '96	
DK kruisende infrastructuur	4TH	J1000.04.TH2	1804TH2	30 mei '96	
DK tunnels Technische installaties	4TJ	J1000.04.TJ2	1804TJ2	30 mei '96	
Samenvoeging infra- en dienst deeltraac 4	4V1	J1000.04.V12	1804V12	30 mei '96	
Gewijz. wakeningen dienst deeltraac 4	4W1	J1000.04.W12	1804W12	30 mei '96	
Zettingvijze plaat vak 4.1	4Z1	J1000.04.Z12	1804Z12	30 mei '96	
Zettingvijze plaat vak 4.2	4Z2	J1000.04.Z22	1804Z22	30 mei '96	
Zettingvijze plaat vak 4.3	4Z3	J1000.04.Z32	1804Z32	30 mei '96	
Zettingvijze plaat vak 4.4	4Z4	J1000.04.Z42	1804Z42	30 mei '96	

Figure 7.2 Fragment of the list of control units [HSL 1997]

Each control unit, as shown in figure 7.2, relates to an organizational process which started when an internal order was given to design team 4. In processing an order, several kinds of documents are exchanged within a team, with other teams within the HSLs, and with external organizations. It is already mentioned that information exchange within a team is not structured. Document exchange with other teams, on the other hand, is highly structured. A document is only allowed to be dispersed outside a team after the document is approved for external use. The information content of documents approved for external use is 'frozen' and the status of the document is adjusted accordingly. In case the information content of the document needs altering, a new version of the document is created. Regarding the dispersion of documents, with respect to the exchange of documents with another team or with an external organization no difference is made. The dominant criterion is the exchange of a document with an actor outside the team which created the document.

Figure 7.3 shows the distinguished document types based on the applications used for document manipulation. According to the definition of document types (see section 6.3.4), each type of document contains a unique set of attributes. Regarding word processing, a number of different document types are distinguished.

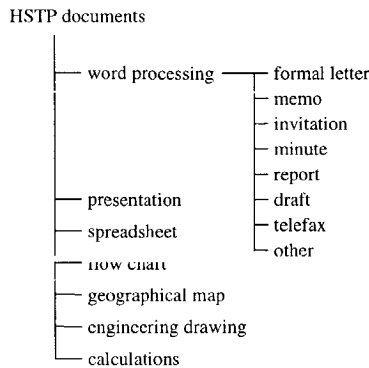


Figure 7.3 Type of documents used by the HSLs

HSLs is established by a number of organizations in which RIB and DHV play an important role (see section 7.1). HSLs's IT is managed as follows: RIB is responsible for the office automation, whereas DHV is responsible for the engineering automation. Office automation includes the MS Dos and Windows environment, while engineering automation includes the UNIX environment. The IT architecture will be discussed later. Office documents such as word processing documents, presentations, spreadsheets, flow

charts, and calculations are created using tools managed by RIB. DHV manages the tools used to draw up the geographical layout of the trajectory design, engineering drawings and 3D CAD models containing the main axis of the rail trajectory.

*Document management in the problem situation*

Currently, a number of procedures occur regarding document management. Regarding these procedures, which are presented below, a distinction is made between document type and document source.

Documents from an external organization are centrally received and forwarded to the appropriate design or expert team. The secretary of a team attends to the registration. Only formal letters are registered. Accordingly, the document is forwarded to the appropriate team member. In case the team member appointed to deal with the matter is not known, the document is forwarded to the team manager who decides on the follow-up. Only registered documents are marked with a unique document identification. In case a team member deals with a document which is not registered, and registration in this case is of importance, the document is returned to the secretary for registration. The registration of incoming and outgoing documents was initially implemented using Pro-Document [TNO 1996]. This application did not meet HSLS's needs. As a result, presently, mail is registered using a letter book. The author of an outgoing document has to decide on the registration. No objective criteria are used for registration. Consequently, important documents are often not registered. This is one of the reasons why HSLS's management initiated the project for designing the electronic document infrastructure.

Engineering drawings and geographical maps are always completed with a drawing number. Drawings and maps are registered by the secretary of a design or expert team on the initiative of a technical draftsman. When the latter starts working on a new drawing or map, the secretary is asked for a new identification number which is registered at the bottom right corner. Drawings and maps are registered using a Perfectview application. Although technical draftsmen are aware of the importance of registering drawings and maps, the Perfectview registration is not up to date. Research showed that out of 317 drawings of one design team, 65 were registered in Perfectview whereas they did not exist electronically, and 26 drawings existed electronically without being registered in Perfectview [Uijlenbroek 1996].

Document creators are responsible for the registration of so-called office documents, such as letters, reports, etc. The Perfectview application is also

used to register office documents. Both the Perfectview application and Pro-Document are used to register meta-information involving documents. Each design and expert team has its own repository for paper documents. A central repository does not exist. As a result of the relative autonomy of teams, they strongly differ in managing paper documents. Overall, it seems, however, that paper documents are managed poorly [EDS 1996]. Concerning electronic documents, office documents are not managed at all. Electronic drawings are managed at the level of a team. Each team has defined a directory structure in which electronic drawings are placed.

#### *Incentives for solving the problem situation*

Due to the progress achieved in political decision making in the beginning of 1996, the focus of the organization shifted from preparing decision making and feasibility studies to project definition and development. Consequently, designing activities became more important resulting in an increasing interest for quality control. At that time, HSL started a project with the aim to apply for the ISO 9001 quality certificate. Furthermore, configuration management according to the ISO 10007 standard [ISO 1995] became an issue. These emerging issues made the organization aware of document management and its current implementation. Document management was typified by a lack of integration of the tools used and informal organizational procedures. As a result, document management was unable to meet quality standards [EDS 1996, TNO 1996]. Consequently, the aim of designing the electronic document infrastructure is to improve the quality of document management, in order to assure the quality of the railway design.

### **7.2.2 Specification and solution finding**

The rough infrastructure design and the detailed implementation design are simultaneously constructed during the process of specification and solution finding. HSL, especially DT4, has participated in determining the features of the electronic document infrastructure. In the following two sections, the final version of these designs are presented. These designs are the result of a number of alterations of specification and solution finding. Section 7.2.2.3 presents the involvement of these designs during specification and solution finding. The influence of stakeholders in the design process is presented in section 7.2.3. Based on an initial measurement regarding document use, quantitative information about the problem situation is presented in section 7.3. As the electronic document infrastructure was implemented in a pilot, the results of the initial measurement are related to the results of a second measurement conducted.

### 7.2.2.1 Rough design

#### *Applying the dominant principle of process control to arrange documents*

The dominant principle of process control is 'control unit'. Consequently, control units are used as the dominant structure for making information accessible. Documents are expected to relate to one or more control units. If this is not the case, the question arises why the document exists within HSLs. Complex control units can contain a large number of documents. Hence, with respect to one control unit, it is necessary to provide additional functions for structuring documents. Regarding these functions, the relative autonomy of team managers plays an important role. Some team managers tend to structure documents chronologically (e.g. according to the progress in the design process) while others prefer documents arranged by topic. The 'heading' concept is introduced for arranging documents regarding one control unit. Team managers are autonomous in naming headings.

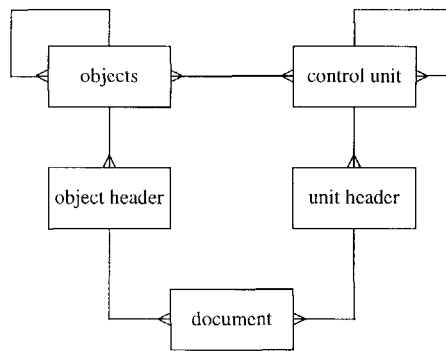


Figure 7.4 Data model representing the accessibility of documents

People working with office documents prefer to use control units and headings in order to improve the accessibility of office documents. Technical draftsmen prefer maps and drawings being accessible by the objects of the object tree, identifying the object(s) a map or drawing relates to. In order to structure maps and drawings with respect to one object, again, the heading concept is used. Consequently, each document - disregarding its type - is arranged according to control units and objects. One is expected to link office documents to control units, whereas linking them to objects is optional. Additionally, one is expected to link maps and drawings to an object, whereas linking them to control units is optional. It is mentioned that the control units and the object tree are defined by the team named 'Line Concept'. This team also links control units to objects. Figure 7.4 shows the data model which represents the accessibility of documents. It shows five

entities: objects, objects headings, control units, unit headings, and documents.

**Architecture**

Figure 7.5 shows the hardware architecture HSLs uses. Each workstation is linked to a network. Unix stations, mostly used by design and expert teams, use the TCP/IP protocol. MS Dos and Windows stations use the Banyan Vines network protocol. Both the Unix environment and the MS Dos/Windows environment are connected to the RIB network by the NS router. Electronic documents are stored on the data servers. Only private documents are stored on local hard disks. From a technological point of view, implementing the data model of figure 7.4 implies both Unix and MS Dos/Windows documents to be arranged within one structure. Consequently, data which are currently stored on different data servers will be managed by one general structure: the object tree and the control units.

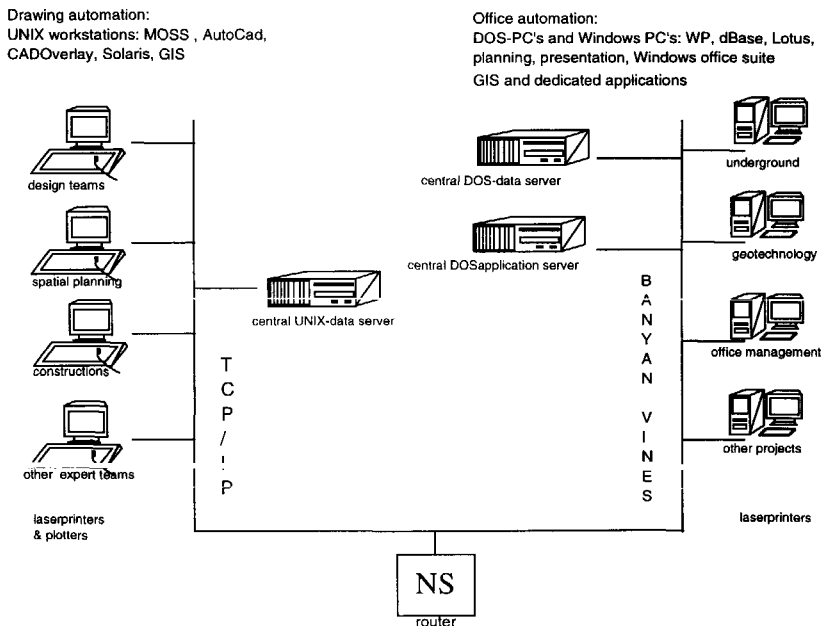


Figure 7.5 Hardware architecture of HSLs [after Corstens et.al. 1996]

Figure 7.6 shows the applications used by HSLs. These applications are used to create electronic documents. Consequently, the output of these applications will be either linked to the object tree, to the control units, or to both, enabling control of these documents. Linking these electronic documents to the document structure can be performed automatically or



manually. Due to existing problems with enforcement of procedures regarding document management, HSLs's management prefers automatic linking. Automatic linking to the document structure requires integration of document manipulating applications with the tool used for document management. This integration can only be implemented in a Windows or Windows-look-a-like environment. Consequently, documents created and manipulated by MS Dos-applications can not be automatically linked to the document structure.

Unix applications	MS Dos-applications	Windows applications
Moss	Wordperfect	Word6.0
Autocad	Dbase	Excell
Autocad overlay	Perfectview	Access
Solaris	Drawperfect	Powerpoint
Gis	Lotus123	Visio
	email	Timeline
	Dedicated calculation applications	

Figure 7.6 Applications used by HSLs

Figure 7.7 shows the proposed software architecture. It distinguishes between the Unix environment and the MS Dos/Windows environment. Each document in the Unix environment is automatically linked to the document structure. Concerning the office documents, only documents created by Windows applications are automatically linked to the document structure. MS Dos documents are linked manually. Regarding automatic linking, two different ways of implementation are possible: prior to or after document creation. Linking prior to document creation requires the identification of the object or control unit the author is going to compile, or both. When implemented in accordance with the latter, each document created will be linked to the document structure. This level of control, however, can not be guaranteed in case an author has to initiate the linking of the document to the document structure. HSLs's management prefers automatic linking, implemented prior to document creation. This choice is based on the demands regarding quality control. Additionally, team managers prefer this way of linking, since it ensures the supply of complete information.

Figure 7.7 shows that the output of MS Dos applications is not managed. To reduce the volume of documents which are not managed, the use of MS Dos applications is discouraged. Windows applications are the standard for word processing, spreadsheet, presentation, and PC-data base. Furthermore, a Windows email application was implemented. Consequently, only the output of MS Dos applications for dedicated calculations is not controlled.

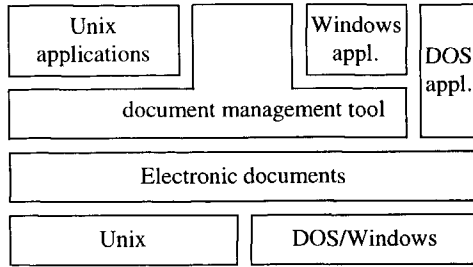


Figure 7.7 Proposed software architecture

*Type of documents and version control*

Besides the two kinds of version control, 'edit version' and 'authorized version' (see section 6.3.4.4), HSLs also distinguishes the status of a document. A document's status depends on the progress of the railway design process. The status of a document changes if, for example, the document is exchanged between teams or when it is used in decision making. If the status or the authorized version of the document changes, the old version needs to be archived.

Document type	Authorized version	Document status	According house style
Formal letter	X	X	X
Memo	X	--	X
Invitation	X	--	X
Minutes	X	--	X
Report	X	X	X
Draft	X	X	X
Telefax	X	--	X
Other word processing doc.	X	--	--
Presentation	X	--	--
Spreadsheet	X	--	--
Flow chart	X	--	--
Geographical map	X	X	--
Engineering drawing	X	X	--
Calculations	X	--	--

Figure 7.8 Document types and applied version control

Figure 7.8 shows that authorized version control applies to each document type, while edit version is not implemented. The idea behind 'authorized version' is the fact that the author has the exclusive option to create a new version of the document. In case a new version is created, the original document is automatically stored in the electronic repository. In case somebody with the appropriate user's rights (often a team manager), has approved the document for use outside the team, the document status is changed automatically.

Figure 7.8 also shows that the layout of a number of office documents is determined by the house style. The house style is implemented in the word processor, using templates and macros. The meta-information captured by the document management tool will be exported to the word processor. Consequently, users only have to enter meta-information once. This linkage also assures that the meta-information printed on the document and registered by the document management tool is consistent.

*Organizational responsibilities*

The organizational responsibilities are derived from the idea that an author is responsible for marginal document registration (e.g. linking it to the organizational context in which it is used). Document management deals with making documents accessible concerning the content.

document related activities	organizational functions			
	document users	team manager	document manager	secretarial support
processing incoming mail	<ul style="list-style-type: none"> <li>processing image</li> </ul>	<ul style="list-style-type: none"> <li>processing image</li> <li>forwarding image appropriate team member</li> </ul>		<ul style="list-style-type: none"> <li>scanning mail</li> <li>forwarding image to appropriate employee or team manager</li> <li>storing original</li> </ul>
processing outgoing mail	<ul style="list-style-type: none"> <li>creating or manipulating document</li> </ul>	<ul style="list-style-type: none"> <li>approving document</li> </ul>		<ul style="list-style-type: none"> <li>printing and sending document</li> </ul>
document distribution: Internal HSLs and external team	<ul style="list-style-type: none"> <li>creating or manipulating document</li> </ul>	<ul style="list-style-type: none"> <li>approving document</li> </ul>		<ul style="list-style-type: none"> <li>creating or manipulating document</li> </ul>
document manipulation	<ul style="list-style-type: none"> <li>registering document attributes</li> <li>searching document</li> <li>changing information content</li> </ul>	<ul style="list-style-type: none"> <li>adding headings to control units</li> </ul>		<ul style="list-style-type: none"> <li>registering document attributes</li> <li>searching document</li> <li>changing information content</li> </ul>
managing electronic repository	<ul style="list-style-type: none"> <li>storing electronic document</li> </ul>		<ul style="list-style-type: none"> <li>adding additional meta information for accessibility</li> <li>assuring accessibility</li> </ul>	<ul style="list-style-type: none"> <li>storing electronic document</li> </ul>
monitoring progress of work		<ul style="list-style-type: none"> <li>monitoring process status</li> <li>adjusting process status</li> </ul>		

Figure 7.9 Organizational functions and document related activities

Figure 7.9 shows the responsibilities of organizational functions with respect to document related activities. These organizational functions currently exist within HSLs. Figure 7.9 also shows a shift in responsibilities compared to the problem situation presented in section 7.2.1. Particularly, document users and secretarial support will be appointed new tasks regarding document

management. It is mentioned that each employee of HSL, creating or manipulating electronic documents, is actually a document user. The document activities are listed in the left column of figure 7.9. Initially, each document created by HSL is created electronically. Besides processing incoming mail, which also means dealing with paper documents, each activity relates to electronic documents. Secretarial support scans documents according to the scan list and forwards the image. The paper document is either stored (e.g. in case of a formal letter) or forwarded to the employee in charge of the matter. The latter implies that the paper document is not managed, and is to be destroyed.

In case documents are created, manipulated or sent, document users (e.g. technical draftsmen, document creators, etc.) are asked to supply the required meta-information. The detailed design presented in the next section, shows which attributes one is expected to fill in, and which ones are optional. In case documents are stored in the electronic repository, additional information may be added in order to assure future accessibility. Examples of additional information are: classifications, descriptions, summaries, headwords, etc. These kinds of additional meta-information can be supplied on the level of a document, an object, a control unit, or a combination of the three. Supplying these kinds of additional information requires documental skills, which appoints the task of the document manager.

Team managers can freely structure documents concerning the control units they are responsible for. This enables them to arrange documents according to their way of working. Consequently, when a team starts working on a control unit, headings need to be specified by the team managers. Document management will implement the specified headings in the electronic document infrastructure.

#### **7.2.2.2 Detailed design**

##### *Document attributes*

Figure 7.10 lists the attributes of each document type. A number of attributes can be supplied automatically, using the login identification of users. Other attributes can be supplied by specifying the task one is working on. A number of attributes have to be supplied by the users.

For each attribute the following aspects are specified [Betagraphics 1997]:

- the type;
- the size;
- the default value (which may be document type dependent);

- the use of a controlled pick list;
- if one is expected to enter meta-information or entering meta-information is optional;
- if the meta-information is generated by the document management tool;
- if the meta-information may be changed after document creation.

Attributes	Document types													
	Formal letter	Memo	Invitation	Minutes	Report	Draft	Telefax	Other word processing doc.	Presentation	Spreadsheet	Flow chart	Geographical map	Engineering drawing	Calculations
Reference	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Creation date	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Edit date	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Title	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Subtitle	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Topic	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Department	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Team	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Author last update	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Telephone	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Railway design phase	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Creating application	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Initial creator	X	X	X	X	X	X	X	X	X	X	X	X	X	X
File code	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Physical location	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sent status	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Archived?	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sent to	X	X	X	X	X	X	X							
Accounting number	X	X				X						X	X	X
Category	X	X				X						X	X	X
Control unit id.	X	X	X	X	X	X	X	X	X	X				
Object id.												X	X	X
Authorizing employee	X					X	X					X	X	
Document status	X				X	X						X	X	
Document version	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Language used	X						X							
Release status					X	X						X	X	

Figure 7.10 Document types and attributes [after Betagraphics 1997]

**Accessibility of documents**

Active documents are accessible through the object tree and the list of control units. This manner of accessibility is closely related to the executed task. Although requiring a search action, documents are also accessible through the attributes listed in figure 7.10.

Documents are only accessible to users if they have the appropriate user's rights. User's rights can be involving objects, control units and specific documents. Consequently, when one starts working on a new control unit,

besides specifying the unit headers, the team manager also needs to specify which team members will be working on the unit. Accordingly user's rights need to be set. An author has ownership of the document and can exclusively remove the document.

Figure 7.11 shows the data model. Compared to figure 7.8, it also includes document types and user's rights. The attributes of each entity are described in Betagraphics [1997].

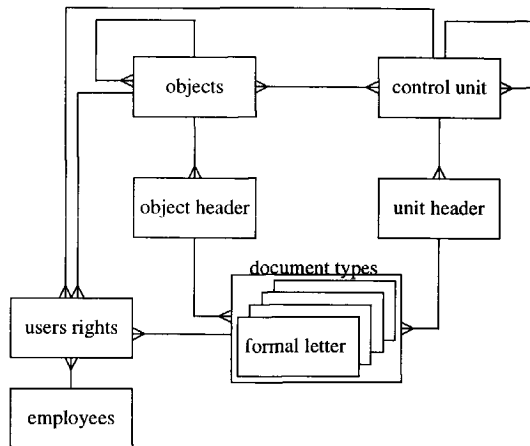


Figure 7.11 Data model representing the accessibility of electronic documents

#### Dealing with hard copies and MS Dos documents

Starting point for the design of the electronic document infrastructure is electronic documents. An organization, however, will always be confronted with paper documents. In order to avoid a dedicated organizational structure for managing paper documents, the electronic document infrastructure is also designed to deal with paper documents. This requires an option to register documents in the electronic document infrastructure without linking the actual document to the infrastructure. This function enables the use of the electronic document infrastructure, similar to traditional postal document registration.

In a similar manner, the electronic document infrastructure deals with MS Dos documents. These documents can also be registered by using the electronic document infrastructure. The actual document can be linked to control units. Manipulation of MS Dos documents is not supported by the electronic document infrastructure. Consequently, MS Dos documents need

to be exported prior to document manipulation and re-imported after document change.

*The choice for a document management tool*

The choice for a document management tool is based on two kinds of criteria: one concerning the way the tool complies with HSLs standards and one concerning the abilities of the tool to meet the design presented in the previous sections [ODRP 1996]. The following HSLs standards need to be met:

- availability in both Unix and Windows;
- supporting the TCP/IP and Banyan Vines network protocol;
- based on an Oracle data base;
- integration with each HSLs Unix and Window application (see figure 7.6).

In addition to the ability to meet the design requirements, the supplier also needs to have a number of related tools available. This is necessary to meet future HSLs demands regarding workflow management, systems engineering, and configuration management. When searching for an appropriate tool, HSLs had no clear idea how to approach these areas. They were, however, convinced of their future importance. Approximately six months after the start of the project for designing the electronic document infrastructure, a project for developing an information strategy started. The information strategy deals with these issues [Corstens et.al. 1996]. An additional criterion is the ability of the software supplier to build a prototype in order to evaluate the design. Given the pressure HSLs put on the project, the software supplier needed short term capacity available.

The search for a tool was aimed at finding a sufficient tool, not the optimal tool. The search started with six different tools, despite the availability of a large number of tools on the market. These six tools differ fundamentally: some are originated from engineering tools, others from document management tools. The following tools were taken into account:

- DM2 of Intergraph;
- Pafec of Betagraphics;
- Docs Open of PC Docs;
- Linkwork of Digital;
- Doc Base of Acanthis;
- Foremost of Provenance.

In order to make a selection, the rough design was presented to each supplier, who was asked for a written statement regarding the implementation of the design.

Pafec is selected to implement the design in a pilot-setting [ODRP 1996]. Decisive factors are:

- Pafec complies with HSLs standards and enables the implementation of the design;
- Pafec has interfacing options to each of HSLs's Unix and Windows applications;
- Pafec includes a number of modules regarding configuration management and workflow management.
- During the selection, it became clear that Pafec is also used by a number of HSLs's parent companies: Holland Railconsult and NS-Infra.

If Betagraphics was not able to build the prototype, the supplier of the second best tools, Docs Open, would be asked to build it. Pafec was preferred over Docs Open due to its roots in the management of engineering drawings, which is very important to HSLs. Furthermore, Pafec was already used by two of HSLs's parents organizations. DM2 has no integration with Moss: the latter being the application used for designing the railway axis, the construction drawings relate to. Doc Base has a pre-defined structure for document management which could not be tuned towards the design. Whereas Foremost focuses on the management of passive documents, the electronic document infrastructure focuses on active documents.

Pafec is a tool based on the client-server concept. A Pafec EDM server holds the meta-information and manages the storage of electronic documents. A Pafec client can either be a Windows PC or a Unix workstation. The Pafec EDM server can be based on Oracle. Pafec includes a number of modules:

- document and data management;
- document imaging;
- workflow;
- reprographics manager;
- document distribution;
- classification;
- free text retrieval.

These modules can be tuned to the user's needs by the availability of a software library which includes a large number of pre-defined document-based functions. Pafec uses a proprietary command language, named HCL, which is quite similar to visual basic, but not compatible [See also Henshell 1996].



*Building a prototype*

Based on the rough and the detailed design, a prototype was built by Betagraphics. The prototype was built to test the feasibility of the design, both technologically and organizationally. Technical feasibility includes fitting the electronic document infrastructure into HSL's technical hardware and software architecture. Organizational feasibility includes the testing of the user's acceptance regarding the functions of the infrastructure and the organizational responsibilities. The organizational feasibility will be presented latter on.

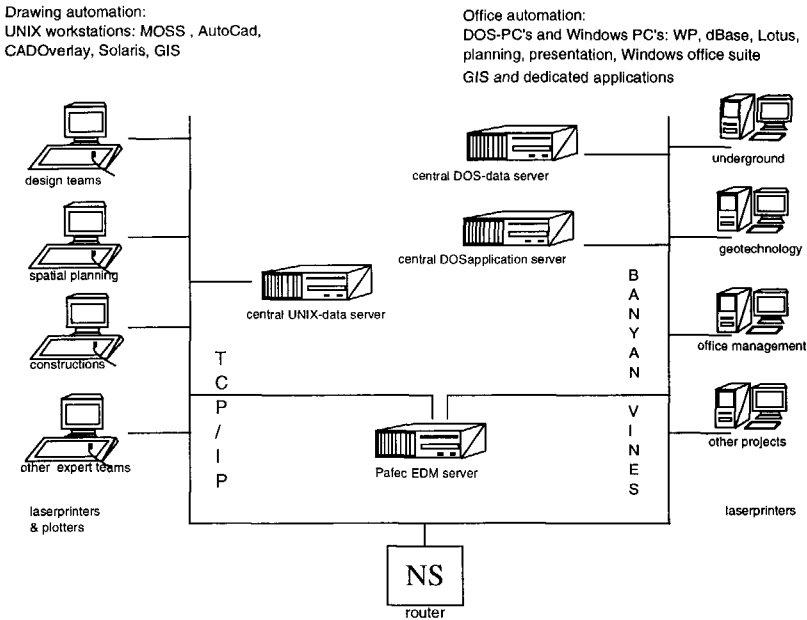


Figure 7.12 HSL's hardware infrastructure including Pafec EDM server

To implement the prototype, the Pafec EDM server is fitted in HSL's hardware architecture, which is shown in figure 7.12. The Pafec EDM server is linked to HSL's network: to the Unix environment by using TCP/IP and to the Windows environment by using Banyan Vines.

A number of technological difficulties emerged during the implementation of the first prototype. These difficulties are briefly described below.

*Incompatible software versions*

The electronic document infrastructure combines a number of applications which operate separately. Consequently, interfaces with Pafec had to be

implemented. During the implementation of these interfaces, problems emerged due to the use of different software versions. HSLs does not apply the most recent version of the operation system SUN OS, a Unix look-a-like operation system. HSLs applies this version because the used MOSS application does not operate in accordance with the latest SUN OS version. DHV, managing the engineering automation, has tested the latest SUN OS version. It was decided that the advantage of the new version does not outweigh the cost of the implementation. Pafec, however, was tuned to the latest version. Another problem of software incompatibility was the use of the English and the Dutch version of MS Word. The visual basic functions implemented in MS Word are language-dependent. This was not noticed until the first test at HSLs, after which translation of the interface with MS Word was required.

#### *Synchronizing user's rights*

User's rights are of importance on the level of the server operating systems, Unix and Banyan Vines, and Pafec EDM. Documents are stored on the Unix server and the Banyan Vines server. To gain access to a certain document using Pafec, one should have the appropriate user's rights on both the operation system level (e.g. Unix and Banyan Vines) and the Pafec EDM level. Consequently, these rights need to be synchronized. A number of dedicated batch programs are built to synchronize user's rights [HSL 1997]. These programs regard the user's rights defined in Pafec EDM on objects and control units as leading, and use them to synchronize Unix and Banyan Vines user's rights.

#### *Document viewing*

The electronic document infrastructure offers similar functions in both the Unix and Windows environment. Electronic documents in the Unix and Windows environment are arranged according to the same structure: the object tree and the list of control units. Consequently, an electronic folder may contain documents of both environments. This enables viewing documents created in one environment, by users of the other. In order to prevent loading the -often heavy- applications, Pafec uses viewer software to show documents. The viewer used, named Imagenation, can deal with a large number of formats in both environments. Documents, however, have to be transferred from one environment to the other, using a dedicated link. The capacity of this link runs short to transfer the expected amount of data. Consequently, cross-viewing is not available in the prototype, although meta-data can be viewed.

*Using the prototype in a pilot project*

In an early phase of the project, DT4 became involved in the project of designing the electronic document infrastructure. DT4 was aware of the documental problems encountered by HSLs and participated freely in the project. The team manager participated in the document management task group (see also appendix A.4). A number of demonstrations was given to members of the design team in order to discuss the functions of the electronic document infrastructure. The prototype was used in a pilot project conducted at DT4. Each workplace of DT4, both office and engineering automation, was included in the pilot project. The pilot project included 12 workplaces. Eventually, two prototypes were tested in the pilot project until the implementation of the system in HSLs's organization was a fact. The way the system changed from prototype 1, through prototype 2, into the implemented system, is discussed in the next section. Section 7.2.3 discusses the participation of stakeholders in more detail.

**7.2.2.3 Repeating specification and solution finding**

In order for the design to become ready to be implemented, specification and solution finding were repeated three times. This section presents important decisions made during each cycle.

*The first cycle: showing the possibilities of the electronic document infrastructure*

At the start of the project, the general design principles for the electronic document infrastructure were accepted. General management and quality management emphasized the importance of document management and arranging documents by control units. This principle, however, was questioned by DT4, which preferred the object tree being the dominant way to access documents. Quality management, at this moment strongly involved in the project, pressed DT4 to accept the principle of control units. At this time, the object tree was not yet completed and some uncertainty regarding the relation between objects and control units arose. The different standpoints of quality management and DT4 are explained by their different interests in the electronic document infrastructure. Quality management strongly focuses on monitoring processes, while DT4 focuses on the design object. The different interests also emerged in document deletion. Quality management prefers document deletion by document management, whereas DT4 prefers documents being deleted by the document creator.

Figure 7.13 shows three 'screen dumps' of the first prototype. The latter was built by Betagraphics based on the rough and the detailed design. These designs were extensively presented and discussed with members of DT4.

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The upper part of figure 7.13 shows the control units, which are represented by maps. The left side of the screen dump presents information regarding the selected map. Each map contains a number of headers, shown in the bottom-left screen dump of figure 7.13. After a header is selected, the documents are shown by a pictogram, which refers to the application used to create the document. This is shown in the bottom-right screen dump.

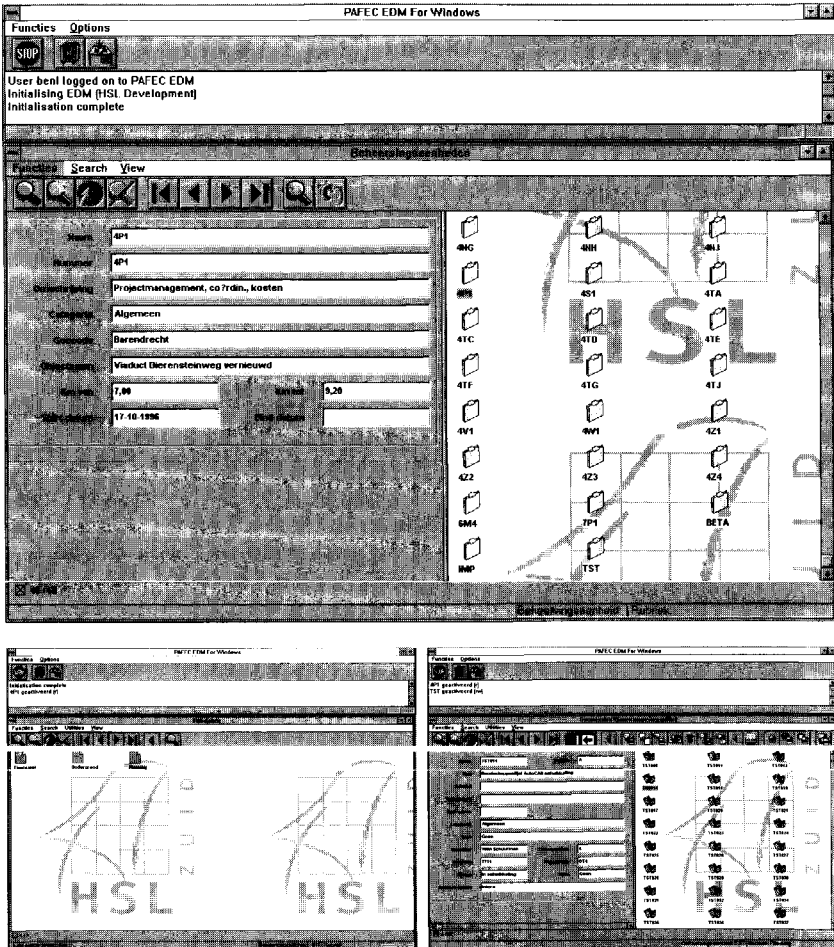


Figure 7.13 Three screen dumps of the first prototype

The first implementation of the prototype is characterized by solving technological problems. A number of these issues are already mentioned in the previous section. A large number of - relatively easy to solve - problems were solved during this phase. For example, problems with installing the

server, the viewer, the scanner and the imaging software, and problems with fitting the prototype into HSLs's software architecture.

The initial prototype triggered discussions involving a number of functions of the electronic document infrastructure. The following functions were discussed:

- specifying document attributes and document types;
- registration of documents;
- organizing the scanning of documents.

The presentation of the rough and the detailed design provoked little discussion. Neither did the general demonstrations of the chosen tools. Demonstrating the prototype, made team members of DT4 aware of its impact on their work. Additional requirements for the electronic document infrastructure were formulated in order to improve user-friendliness and acceptance. An example of the first is the option to continue with the document last used, without browsing through control units and headings. An example of the second is the ability to create documents which are not related to a certain control unit. Strictly spoken, this is not possible. In practice, however, this occasionally occurs: 'drawing a floor plan of the private kitchen' remains possible. This ability is highly important, due the request of the team manager to install the electronic document infrastructure as the opening screen.

These kinds of system changes motivated future users to closely examine the prototype. They noticed that their remarks had had an impact on the final shape of the system. Nevertheless, it also generated a number of questions and issues which in an earlier phase were disconnected to the project. An example being the linking of the house style to the electronic document infrastructure. During the design of the electronic document infrastructure, a new house style was designed and implemented using MS Word. These projects were disconnected: the house style would be linked to the electronic document infrastructure, prior to the general implementation of the electronic document infrastructure. After the house style was implemented, the pilot group insisted on linking the house style to the electronic document infrastructure.

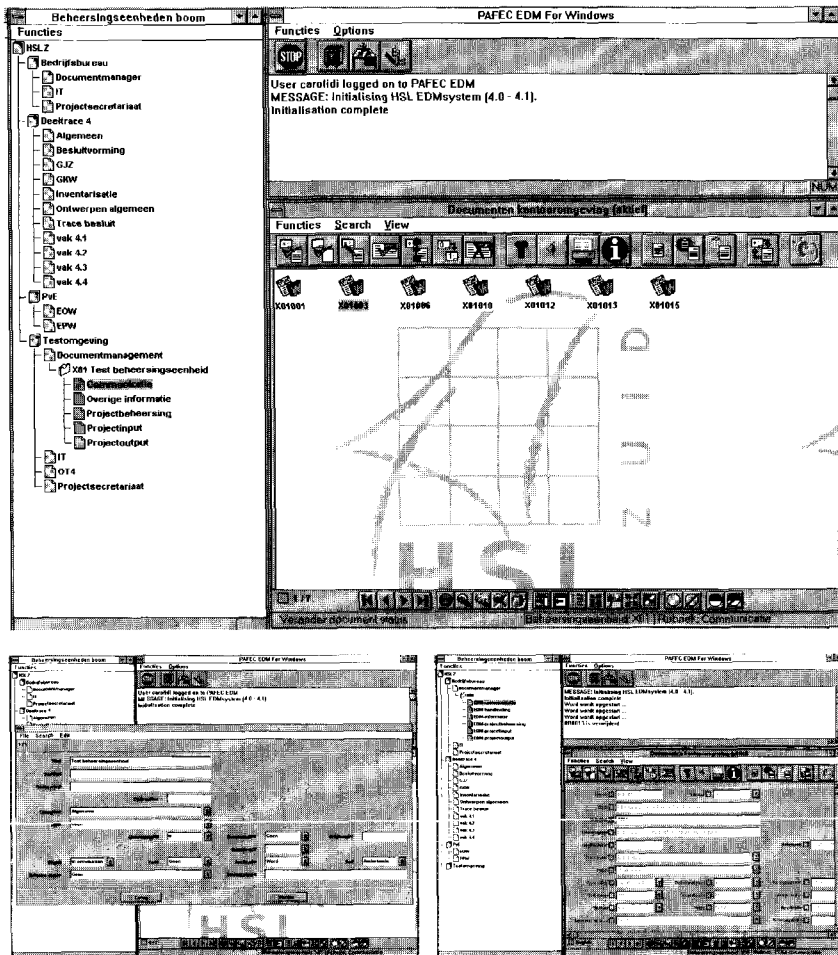


Figure 7.14 Three screen dumps of the second prototype

*The second cycle: implementing user's requests*

The first prototype focused on technological aspects of the system and the identification of user's needs, while the second focused on fine tuning of the functions of the electronic document infrastructure and implementing the prototype in the pilot group. Figure 7.14 shows three screen dumps of the second prototype. The upper part shows a tree, representing control units and headings. Visualizing the structure of documents was one of the questions of the pilot group in response to the first prototype. It is implemented using a so-called structure catcher which was made available by Pafec at the end of 1996. The bottom-left screen dump of figure 7.14 shows the attributes one has to enter in order to create a document. The

bottom-right screen dump shows how a document can be searched. The search of a document is hierarchically executed from the position one points to in the tree: underlying control units and headers are searched for documents which meet the search criteria.

The pilot group has tested the second prototype for approximately 6 weeks: it was used during their day-to-day work. Existing electronic documents were imported to the electronic document structure. Consequently, these documents were only accessible through the electronic document infrastructure. During this phase, users support showed to be highly important. After the system was implemented and the users were provided with an instruction, the system was used infrequently. New documents were created without using the electronic document infrastructure<sup>31</sup>. Actively approaching the users, by frequently asking them about problems encountered, encouraged them to use the system. To ensure an active approach, a member was added to the document management task group. This person was seated, together with the document manager, next door to DT4. This location enabled informal discussions involving the electronic document infrastructure. These discussions showed to be an important tool to promote the electronic document infrastructure and provided information about problems encountered by DT4.

Document types was one of the topics which emerged during this phase. Until now, in order to launch the appropriate applications, a document type needed to be selected. Users preferred having a visual presentation of document types, using it in order to access documents by type. This option, actually similar to the way paper documents are located by external characteristics, is implemented in the final system.

The implementation of the prototype required the listing of control units used by DT4. Control units are centrally defined and monitored. It was shown, however, that two applications were used for registering: Dataperfect and Access. These registrations were not entirely consistent. The use of these two applications was narrowed down to the preferences of individual employees. The implementation of the prototype requires clearness about which registration is the original source of control units. Eventually, this was clarified by HSLS's management. Section 7.2.1 already presented inconsistencies regarding the registration of drawings and maps using the Perfectview application. These inconsistencies required the conversion of

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<sup>31</sup>During this phase, due to technological problems the electronic document infrastructure was not yet started automatically after logging in to the system.

drawings and maps to the electronic document infrastructure in presence of the creator, who was able to remove them.

During this phase, the discussion regarding the basic structure of making documents accessible re-emerged. DT4 required the object tree instead of control units as the dominant structure to access documents. This requirement can be explained by the relation of drawings and maps with the output of HSLs: the design of a railway. Finally, quality management and DT4 agreed on implementing both structures simultaneously, the object tree being the dominant structure to UNIX documents, and the list of control units to office-documents. As shown in figure 7.4, control units and objects are related (n:m).

*The third cycle: preparing the final version*

In the final version of the electronic document infrastructure, documents are presented to users in two ways: arranged by objects and control units. These structures exist simultaneously. There is in fact a third structure: types of documents used in combination with the other two structures. Figure 7.15 shows three screen dumps of the final system. The upper part shows the list of control units and the types of documents. Documents are visually presented in the structure. This is shown in the bottom-left screen dump of figure 7.15. This screen dump also lists the functions regarding document manipulation. The bottom-right screen dump shows document exchange.

The following functions are implemented in the final version of the electronic document infrastructure [HSL 1997]:

- registering paper documents;
- registering electronic documents and document manipulation;
- copying documents;
- importing and exporting electronic documents into the electronic document infrastructure;
- version and status of documents;
- deleting documents;
- checking in and -out of electronic documents;
- archiving electronic documents;
- sending documents;
- searching electronic documents;
- using house style;
- listing documents;
- archiving documents.



## CASE 4: APPLYING THE DESIGN APPROACH

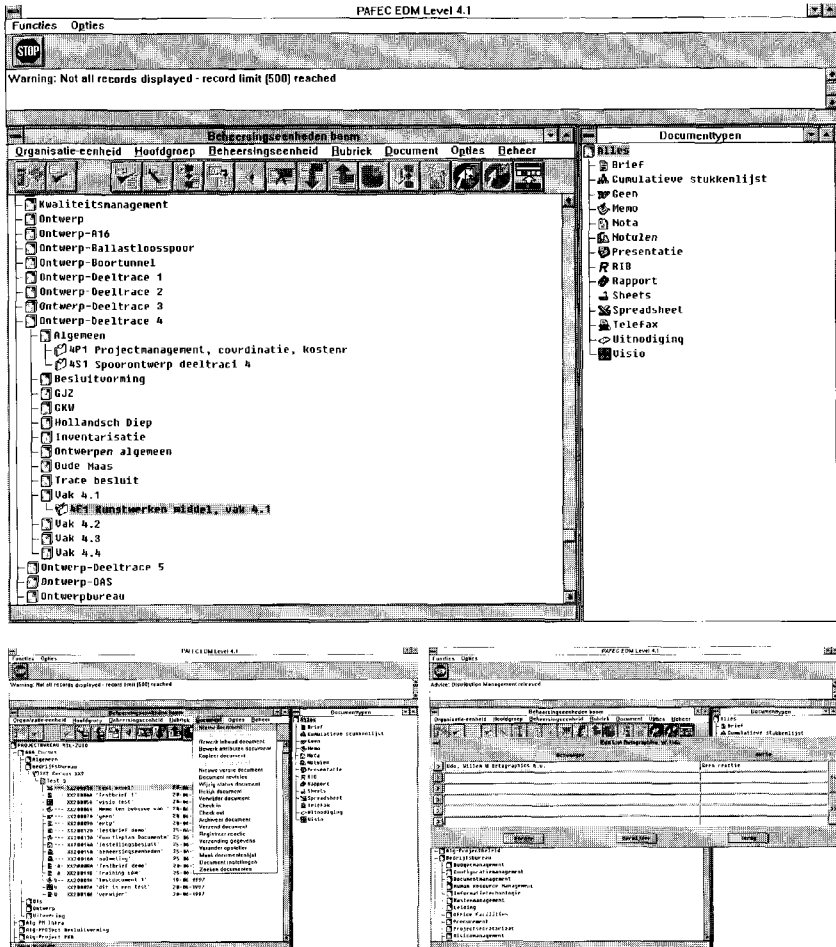


Figure 7.15 Three screen dumps of the final version

The final version is used for the general implementation at HSL. The use of the prototype in the pilot project contributed to the design of a number of related functions. These are scheduled to be implemented shortly after the general implementation [HSL 1997]. These functions are:

- routing of documents according to a pre-defined workflow;
- integration of document management and an action and completion list.

### 7.2.3 Participation by stakeholders

The design of the electronic document infrastructure involved a number of actors with partly overlapping and partly contradicting interests. The following actors are distinguished:

- general management and quality management, whose major interest (in this context) is to ensure organizational effectiveness;
- IT management, whose interest is to ensure reliable IT support for the organization;
- team manager, whose basic interest is to fulfill internal orders;
- team member, whose basic interest is to perform assigned tasks;
- configuration management, whose basic interest is to ensure the supply of complete and reliable product information;
- document management, whose basic interest is to ensure the supply of complete and reliable document management;
- RIB, whose interest is to receive a qualitative railway including complete and reliable documentation in the future.

Each of the actors mentioned were represented in the document management task group, except configuration management and RIB (see also appendix A.4).

The interests determine the way parties are involved in the project and explain why the focus of a number of parties shifted during the project. General management and quality management strongly participated during the start of the projects. Initially, the quality manager was the chair of the project, until the project structure described in appendix A.4 was implemented. General management and quality management strongly participated until the rough design was established. Design principles regarding registering documents and the accessibility of documents were determined by the general management. The focus of general management shifted from determining design principles to budget control and monitoring progress.

IT management was involved from the beginning of the project. Their participation, however, increased after document management tools were selected. Based on their interest in ensuring reliable IT support, they were concerned with the high level of integration necessary to implement the electronic document infrastructure. IT management obviously participated in implementing in the prototype into HSL's hard- and software architecture.

Both the team manager and the team members participated in shaping the functions of the electronic document infrastructure as described in the previous section. It is mentioned that the supplier of the document management tool, Betagraphics, also had an important input at this point, based on their knowledge of the tool. The input of the team manager and the team members significantly increased after the first prototype was

implemented. Until then, they gave little response to design proposals and made little suggestions regarding the design.

At the start of the project, configuration management was repeatedly interviewed regarding the identification of drawings. During this phase, the used protocol for drawing identification changed a number of times. The department of configuration management increased strongly during the project of designing the electronic document infrastructure. Initially, they had no capacity to participate in the project. After the implementation of the second prototype and the IT planning project was nearly finished, they actively searched for ways of using the electronic document infrastructure in order to shape configuration management. This is described in more detail in section 7.4.

Actors	Rough design	Prototype 1	Prototype 2	Final design
<b>General management</b>	determining design principles	budget management and monitoring progress		
<b>Quality management</b>	determining design principles	contributing to shaping the functions	monitoring progress	
<b>IT management</b>	assuring technical feasibility	assuring technical feasibility and implementation		implementation
<b>Team manager and team members</b>	monitoring	shaping the functions and testing		using the infrastructure
<b>Configuration management</b>	monitoring	shaping functions	searching for integration with configuration management	monitoring
<b>Document management</b>	did not exist yet	user support		project management
<b>RIB</b>	stressing the use of standards	monitoring		

Figure 7.16 Participating actors and their involvement during the project

Since the start of the project, HSL had no department for document management. HSL asked a consultancy firm to participate in the project, which was when the author became involved. During the implementation of the first prototype, the document management department was installed and it was agreed to hand over the project to document management. This occurred during the second pilot. Document management played an important role in motivating pilot-users to employ the system and encouraged them to reply to design proposals. As the pilot became operational, document management was available to deal with problems and to assist users.

RIB was merely involved at the beginning of the project. Their main input was to ensure the choice of a tool which enables document management after the railway is completed. Consequently, RIB stressed using the

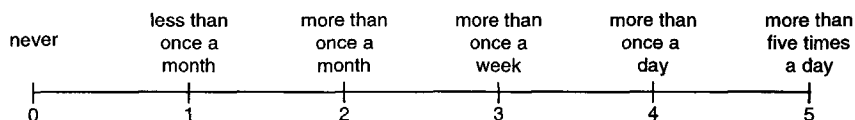
standards of HSL's parent organizations. Figure 7.16 lists the actors and their involvement in the project over time.

### 7.3 Evaluating the electronic document infrastructure

#### 7.3.1 Introduction

DT4 used the second prototype with its regular operations for a period of six weeks. Document use by DT4 was measured at the start of the project, and was repeated after six weeks. Document use by DT4 is measured using a structured questionnaire. In order to determine the frequency of document use, a six point Lickert scale [Mitchell and Jolley 1992] with pre-defined frequencies was used. An example is given below.

*How often do you receive electronic documents?*



The advantage of using Lickert-type scales is that they yield more information than nominal-dichotomous items. More importantly, unlike dichotomous items, Lickert-type scales enable more powerful statistical tests, such as the *t*-test [Mitchell and Jolley 1992].

The questions on the questionnaire are presented in tabular format holding a number of different kinds of items (see Appendix D for the questionnaire and results). In order to determine the amount of time spent on document management by DT4 members, an additional column is added, asking for the average time of one action. Figure 7.17 shows one question of the questionnaire.

The questionnaire includes five parts: document use, availability of documents, creating documents, retaining documents, and version control. Appendix D also holds a detailed presentation of the results.

A *t*-test is used in order to determine the significance of differences between measurement 1 ( $M_1$ ) and measurement 2 ( $M_2$ ). The significance level used is  $\alpha = 0.05$ . The pilot included 12 workplaces, used by nine people who participated in  $M_1$ . Only seven people participated in  $M_2$  due to high work pressure. The following section discusses the results.

**How often do you search for a document (paper or electronic or both), what kind of search strategy do you apply and, on average, how much time does it take?**

*The table below shows a number of search strategies and a scale referring to the number of times the search strategy is executed. It also shows a column to fill in the average time of one search action in minutes. Please, add any missing search strategy.*

Search strategy	Number of times executed*						Average time in minutes of one search action
	Never	Less than once a month	Less than once a week	Less than once a day	Less than 5 times a day	More than 5 times a day	
Ask a roommate of DT4 (e.g. Do you have that document?)							
Obtain information of an HSTP-colleague by phone (e.g. Do you know where the document is or who it has?)							
Obtain information of an other organization by phone							
Searching in your own files (e.g. where do I keep it?)							
Searching in the files of the design team							
Searching in the files of a colleague							

Please mark the appropriate frequency

Figure 7.17 Example of one question

### 7.3.2 Results

The use of prototype 2 in the pilot did not result in a significant change regarding the use of applications (questions 1, see Appendix D). M<sub>2</sub>, however, shows a significant decrease in the use of WordPerfect compared to M<sub>1</sub>. HSLs used the MS Dos version of WordPerfect. At the start of the pilot, DT4 switched to Windows applications. M<sub>2</sub> does not show a significant increase in the use of MS Word, because a number of DT4 members already used this application.

Figure 7.18 shows the frequency of document use based on the arithmetic mean of the Lickert scale. Overall, M<sub>1</sub> and M<sub>2</sub> show no significant difference in the number of times both electronic and paper documents are used by DT4. M<sub>2</sub>, however, shows a significant decrease in the number of times a project assignment is represented on paper, and an increase in use of documents belonging to the category 'others' (questions 2 and 3). The category 'others' includes fax-documents which were not taken into account by M<sub>1</sub>. It is concluded that the total amount of documents used by DT4 did not change between M<sub>1</sub> and M<sub>2</sub>. This conclusion is supported by the answers to questions 4, 5 and 10. Questions 4 and 5 show that no changes occurred in document exchange. Question 10 shows that no changes occurred in the

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amount of electronic documents created by DT4. The time used for document creation, including obtaining the appropriate document identification and registering meta-information, did, however, increase significantly: from 3.07 to 5.38 minutes (question 10).

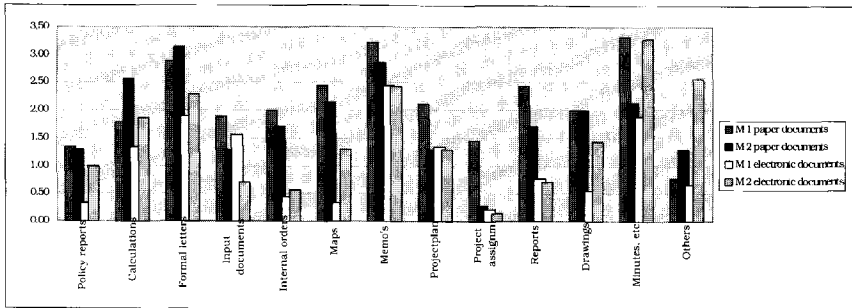


Figure 7.18 Relative frequency of document use (see also appendix D, questions 2 and 3)

The answers to questions 6 and 7 show that the accessibility of electronic documents significantly increased. The accessibility of the following document types increased: calculations, formal letters, maps, memos, project assignments, and minutes. The latter also includes agendas and invitations to meetings. These kinds of document types are used relatively frequent (see figure 7.18). The accessibility of *paper* documents did not change (question 6), which is expected because prototype 2 is only used to manage *electronic* documents.

The improved accessibility resulted in a significant decrease of both the number of search actions undertaken by members of DT4 and the time spent on searching documents (questions 8 and 9). The number of times team members actually searched in their private repository significantly decreased. Also, the number of times a roommate was asked about a document decreased. The number of times one searched in the repository of the design team or in the repository of a colleague did, however, not decrease. The average time spent on one search action significantly decreased from 5.5 to 2.4 minutes. The amount of time one was involved in search actions initiated by somebody else also significantly decreased from 4.4 to 1.4 minutes.

The answers to questions 11 and 12 show that no significant changes occurred in managing *paper* documents. The number of *electronic* documents stored in a private repository strongly decreased. Formal letters, input documents, internal assignments, memos, and minutes are less frequently stored in private electronic repositories. This shows that

prototype 2 offers a suitable tool for EDM, reducing the need to keep documents in a private repository. Besides the number of documents put in private repositories, the time spent on private document management significantly decreased from 3.8 to 2.4 minutes per document.

The answers to questions 13 to 15 show that doubts regarding document version and status significantly decreased. Furthermore, the number of times these doubts resulted in a search action decreased, similar to the number of times one actually started working with a document of the wrong version or status. These improvements especially occurred with respect to formal letters and drawings, which are important documents. Formal letters are of importance due to their evidential value, whereas drawings are of importance to the fact that they are the output of the engineering process. Consequently, it is concluded that by the reduction of doubts with respect to the version and status of these kinds of documents, the organizational effectiveness is improved.

It is shown that the volume of documents did not change between  $M_1$  and  $M_2$ . Using the *ceteris paribus* clause, it is concluded that changes in the use of documents and the time spent on document management, are the result of the use of prototype 2.

The extra time spent on document creation (from 3.07 to 5.38 minutes) is expected to be recovered by the reduction of time spent on searching (from 5.5 to 2.4 minutes) and managing private repositories (from 3.8 to 2.4 minutes). A tentative calculation is made using these averages and the number of time these documental actions are executed. In order to make this calculation, the following assumptions are made:

- one year includes 220 working days of 8 hours;
- less than once a month relates to 6 times a year;
- less than once a week relates to 27 times a year;
- less than once a day relates to 110 times a year;
- less than 5 times a day relates to 550 times a year.
- more than 5 times a day relates to 1100 times a year.

These assumptions use the median of a class interval multiplied by 220, the number of one year's working days.

Figure 7.19 is constructed using the data of appendix D regarding document creation, searching documents and managing private documents. Figure 7.19 shows the time spent on document management by one team member per year, and as a percentage of one year's working time. Using the tentative calculation, the time spent on document-related actions is reduced with more

than 50%. One should realize that the total time spent on document related actions is approximately 10% percent of the total working time. This implies that, expressed as a percentage of total working time, the reduction of time spent on documental actions is only 5%.

	Measurement 1		Measurement 2	
	hours	% working time	hours	% working time
Creating	25.92	1.47%	40.56	2.30%
Searching	105.73	6.01%	20.30	1.15%
Managing	66.00	3.75%	17.59	1.00%
Cumulative	197.65	11.23%	78.45	4.46%

Figure 7.19 Time spent on document related actions of one team member per year

#### 7.4 Developments within HSLs

During the designing and testing of the electronic document infrastructure, HSLs introduced configuration management (CM) for structuring the design object and maintaining up-to-date information. CM includes configuration identification (object identification and its relations with other system parts), configuration control, configuration status accounting, and configuration audit. CM became the starting point for shaping the information architecture of HSLs.

CM and the electronic document infrastructure overlap. CM extends process control as defined with respect to the electronic document infrastructure. Future developments regarding CM were amongst the criteria used for selecting a tool for the implementation of the electronic document infrastructure. The electronic document infrastructure relates documents to the object tree and the control units. The object tree and the control units used for document management can easily be used for CM. This emphasizes the infrastructural character of document management. Furthermore, the importance of linking documents to an overall structure of organizational processes and a general principle of process control are underlined here.

#### 7.5 Discussion of the design approach

HSLs's electronic document infrastructure is designed according to the design approach presented in chapter six. The latter is characterized by concurrent design of both the rough and the detailed design. Distinguishing between these designs enables the structuring of the involvement of stakeholders. For instance, the design principles, being part of the rough design, are discussed with general management, whereas the functions of



the electronic document infrastructure, being part of the detailed design, are discussed with future users in more detail. Furthermore, distinguishing between these designs enables the delegation of design tasks to the supplier of the document management tool. ODRP is responsible for the rough design, whereas Betagraphics is responsible for the detailed design. After accepting the design principles by HSL's management, the focus shifted from the rough to the detailed design. The involvement of stakeholders shifted accordingly (see figure 7.16).

Specification and solution finding were repeated a number of times until the design was accepted by the stakeholders for company-wide implementation. The design evolved: it can not be stated that a number of clear-cut alternatives were evaluated. A number of design decisions were made rather implicitly: based on the prototype, changes were proposed by users, and after evaluating them, a decision regarding the implementation was made. Consequently, the design process is less structured than assumed in the design approach. Instead of seeking for the optimal solution, one generates alternatives and settles for a solution which meets the user's needs. In line with this view on the design process, instead of, for instance, enumerating documents, it is more important to direct the design process and to ensure stakeholders' accurate participation. Understanding the richness of the documents used and overseeing future consequences of design decisions are very important aspects. This is illustrated with respect to CM. At the start of the project, HSL's use of CM was not clear. Neither was its relation to the electronic document infrastructure. By the end of the project it was possible to use the electronic document infrastructure as a foundation for implementing CM. This emphasizes the infrastructural character of company-wide electronic document management.

The design of the electronic document infrastructure may be regarded a relatively smooth-running process. One should realize its effect on the entire organization. The design of the electronic document infrastructure started a rather distorted discussion about process control on an organizational level. During the design process, the focus shifted from object to control units, and finally resulted in two principles used to access documents. During the design process, the focus shifted from documental problems to organizational problems, and finally to technological problems. Overseeing the project, process control is explicated and partially (re)structured, and both documental procedures and the use of software applications are restructured. It is expected that only straightforward concepts can be implemented company-wide.

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The electronic document infrastructure reduces the time spent on documental actions. Document creation consumes more time, which is regained in searching documents and document management. A tentative calculation shows that approximately 10% of the working time is spent on documental actions, which may be reduced to approximately 5%. Consequently, it is concluded that implementing the electronic document infrastructure contributes to HSL's efficiency. These improvements, however, are limited.

To HSL, complete and up-to-date information is essential in reaching its organizational objectives: completion of a solid high speed railway with appropriate documentation for maintenance. Hence, complete and up-to-date information has an impact on HSL's effectiveness. The evaluation of the second prototype shows a significant improvement of accessibility of electronic documents, resulting in a decrease of the number of search actions conducted. Furthermore, the evaluation shows a decrease in the number of times a document of the wrong version or status is used. Hence, it is concluded that the electronic document infrastructure contributes to HSL's effectiveness.

## 8. Epilogue

### 8.1 Introduction

The increasing use of electronic documents results in a number of problems which are presented in chapter 1. This research focuses on problems relating to capturing critical information, the media richness, the accessibility, and the authenticity and integrity of electronic documents. These problems are new, requiring a new theory. An electronic document infrastructure is proposed in order to solve these problems at an organizational level. The objective of this research is to build a theory regarding the design of an electronic document infrastructure. The theory is based on archival, organizational and technological concepts presented in chapter 2. The theory regarding the design of an electronic document infrastructure, presented in chapter 6, is based on three inductive cases. The theory is applied to one case, using action research. This chapter answers the research questions formulated in chapter 2 and discusses the proposed design approach and the research approach.

### 8.2 Answering the research questions

#### 8.2.1 Research question 1

*Which capabilities should an electronic document infrastructure possess in order to support a wide variety of organizational processes?*

The ability of an electronic document infrastructure to support a wide variety of organizational processes, requires supporting both process control and document management. Cases 2 and 3 in particular, show that integration of process control and document management is important in order to ensure complete and up-to-date information concerning document management. Furthermore, these cases show that separating document creation from registration results in outdated information. Based on the inductive cases, it is concluded that the integration of process control and document management is essential to an electronic document infrastructure. This integration also enables document registering by document creators in the workplace. Additionally, it enables the linking of documents to the organizational context, e.g. the organizational process including its process status.

Case 4 shows that, in order to ensure the universal character of an electronic document infrastructure, it has to contain an overall view of organizational

processes (e.g. a process tree). Furthermore, the ability to define different ways of monitoring processes is required: supporting different kinds of status and different ways of status control. Moreover, an electronic document infrastructure has to enable the linking of each document to an organizational process, independent of the software applications used. Complete documental information is ensured only when an electronic document infrastructure is integrated with each application used to process less-structured information. Also, the ability to support managing paper documents is required (e.g. scanning and registering of paper documents). Furthermore, complete documental information requires the document creators to be motivated to register their documents. Consequently, an electronic document infrastructure needs to be available at each workplace, integrating document registration and task execution.

### 8.2.2 Research question 2

*Which kinds of organizational processes, categorized by their characteristics and document use, can be supported by an electronic document infrastructure?*

The central concepts in answering this question are 'predictability of organizational processes' and 'predictability of document use'. This question is answered with regard to the *direct* support of organizational processes by the electronic document infrastructure. Indirect support is not included. Chapter 1 argues that the information content of a document and its manipulation, relate to organizational processes and output. Chapter 2 presented a view on organizational processes containing three levels of analysis: organizational chain, processes and activities. Regarding a certain process, each of these levels can be either well- or ill-structured. Cases 2 and 3 show that when the document relates to ill-structured processes and activities, the information content of a document and its manipulation are difficult to predict. Case 1 shows that well-structured processes using well-structured information, such as the IRS process, have a high level of predictability. Both the structure of such a process and the information used, enable the use of dedicated tools. The latter is particularly welcome due to the high volume of the process. Case 1 shows that such a process should not be supported by an electronic document infrastructure. An electronic document infrastructure focuses on organizational processes with a low predictability of the sequence of activities and document use.

In order to ensure a universal solution to problems concerning electronic document management, an electronic document infrastructure has to

support as many different organizational processes as possible. Case 4 shows that processes which can be supported appropriately:

- contain a relatively large number of ill-structured activities;
- require process control which only distinguishes a limited number of phases;
- enable the identification of a dominant principle of process control, such as control units in the HSLs case;
- use documental information which is available electronically.

The processes studied in cases 2 and 3 are also examples of such processes. Cases 2, 3 and 4 also have in common that employees involved in the processes studied are professionals. Furthermore, the volume of these processes is relatively low.

### **8.2.3 Research question 3**

*How can one balance optimal process support and universal features of the infrastructure?*

The first step in balancing optimal process support and universal features of the infrastructure is taken by answering research question 2. Although this may appear to contradict the universal features of an electronic document infrastructure, the processes to be supported are relatively homogeneous. The universal features of the electronic document infrastructure relate to the ability to support a maximum number of processes with a low level of predictability. Within the domain of this kind of processes, differences regarding types of documents, distinguished process phases, required version control, etc., do exist.

An important step in balancing optimal process support and universal features of the electronic document infrastructure is identifying or constructing a general concept of process control. This concept should apply to a large number of processes supported by the infrastructure. Case 4 shows that more than one dominant principle of process control may be expected, such as control units and objects, which may consequently be linked. Furthermore, case 4 shows that the processes to be supported do not need to be described or structured into detail, it is sufficient to identify the phases which are used to control the processes. A general concept of process control reduces differences existing between processes. It also enables the integration with other process-related issues, such as budget control and time-accounting by employees. Case 4 shows that such a general concept enabled integration with configuration management. These kinds of integration illustrate the infrastructural character to users. This

contributes to the awareness that optimal process support might satisfy them, but is sub-optimal to the organization. This justifies the strive for a satisfying rather than an optimal solution.

#### **8.2.4 Research question 4**

*What is the contribution of an electronic document infrastructure to an organization's effectiveness, efficiency and manageability?*

This question is answered by using the results of case 4. The question contains three criteria used to evaluate the contribution of an electronic document infrastructure to an organization. These criteria are separately discussed below.

##### *Contribution to an organization's effectiveness*

Organizational effectiveness relates to the degree in which an organization reaches its objectives. Concerning HSLs, the objective is to deliver a solid high speed railway with additional appropriate documentation for maintenance. The effectiveness of HSLs relates to the quality of the railway and the quality of the documentation. Supplying complete and up-to-date information during the design process is a necessity for producing a solid railway. Furthermore, documentation for maintenance requires the availability of complete and actual information after the design and the construction of the railway.

Complete information is measured using the number of times documents are not immediately available and the number of search actions conducted. Case 4 shows that the introduction of the electronic document infrastructure significantly improved the accessibility of electronic documents. This resulted in a decrease of the number of search actions conducted. Up-to-date information is measured by using the number of times doubts concerning a document's version emerged, the number of times these doubts result in a search action, and the number of times one used a document of the wrong version or status. Case 4 shows that the introduction of the electronic document infrastructure significantly decreased the number of times doubts concerning a document's version or status emerged, and the number of times these doubts resulted in the search of a document. Furthermore, case 4 shows that the number of times one used a document of the wrong version or status decreased significantly. Consequently, it can be concluded that, by improving complete and up-to-date information, an electronic document infrastructure significantly contributes to an organization's effectiveness.

*Contribution to an organization's manageability*

Cases 2 to 4 show that an organization's manageability, defined in terms of management information regarding process and document status, is part of the initial problem situation encountered by the management. The answer to research question 1 shows that the integration of process control and document management is an essential part of an electronic document infrastructure. Furthermore, an electronic document infrastructure ensures that all information is captured by making the infrastructure available at each workplace and integrating document registering with task execution. Additionally, documents are linked to processes, ensuring complete information including status information of documents and processes. Case 4 shows that, as a result of the introduction of the electronic document infrastructure, the number of times a private repository was searched, significantly decreased. Consequently, it is concluded that an electronic document infrastructure significantly contributes to an organization's manageability.

*Contribution to an organization's efficiency*

The contribution to an organization's efficiency is measured by the time spent on creating, searching and managing documents. Case 4 shows that the introduction of the electronic document infrastructure significantly increased the time spent on document creation. This increase is compensated by the time spent on searching and managing documents. Combining these outcomes, case 4 shows a significant decrease of 50% in the time spent on document handling. A tentative calculation, however, shows that the time spent on document handling is only 10% of the total working time. Consequently, the contribution to an organization's efficiency expressed in the total working time, is approximately 5%. Following this line of reasoning, it can be concluded that an electronic document infrastructure contributes little to an organization's efficiency.

**8.3 Linking the results to problems regarding electronic documents**

A number of document related problems are presented in chapter 1. With a focus on active documents, the research area is delineated to the following problems (see section 1.4):

- capturing critical information;
- media richness;
- improving the accessibility of information;
- authenticity and integrity of electronic documents.

This section discusses the answers to the problems dealt with in the case-studies. First, capturing critical information. Several ways of capturing critical information are applied: automatically, on the initiative of secretarial employees and on the initiative of a professional employee dealing with the document's information content. Due to the importance of complete and up to date information to the effectiveness of HSLs, the general management of HSLs required capturing information automatically. This provided HSLs with an opportunity to deal with the high amount of information electronically created within the organization. The management of HSLs insisted on document registration prior to document creation.

Since documents are stored and managed in their original format, the case-studies did not provide a problem regarding media richness. As long as appropriate viewer-software or the application by which a multi-media document is created are operational, the document remains accessible. Consequently, it is important to use widespread applications, which should be organizational standards.

The accessibility of information is improved by linking documents to organizational processes. Furthermore, as documents transform from active to passive, based on the information content additional meta-information is added to improve the accessibility.

The authenticity and integrity of documents is guaranteed in two ways. First, user's rights ensure that only authorized users may manipulate a document and its status. Furthermore, in case of a document's deletion, the information is not really removed, but made inaccessible to regular users. The document manager maintains access to the document and the ability to delete it. Secondly, after creating a document, automatically generated meta-information is added. The meta-information uses the information of the user's log in account. Although the information is difficult to change, this way of working is not completely waterproof. Consequently, a number of procedural measures are taken to ensure the authenticity and integrity of documents. In case documents contain a high evidential value, these also have to be stored on hardcopy.

#### **8.4 The design approach**

In section 2.4 it is stated that *the objective of this research is to construct a theory regarding the design of an electronic document infrastructure*. This theory is presented in a methodology for designing electronic document infrastructures. The research questions highlight certain parts of the theory.



This section discusses the methodology in a broader sense, using the results of the HSLS case.

#### *Way of thinking*

Section 6.3.2 presents the way of thinking regarding the methodology for designing electronic document infrastructures. The way of thinking regarding a methodology determines the way in which problems are perceived and what kind of solutions need to be taken into account. It also determines the problem area a methodology can be successfully applied to. The HSLS case shows that the major contribution of an electronic document infrastructure is to the effectiveness and manageability of an organization. Section 6.3.1 confines the problem domain to *organizations encountering document management problems while executing goal-oriented document-based processes*. Since the problem is confined to goal-oriented processes, efficiency-problems do not play an important role in the problem situation. In case 1, efficiency related issues, however, are relevant regarding budget cutting and in case 2 regarding supporting units. Based on the findings of case 4, the problem domain of the methodology for designing an electronic document infrastructure is further specified by referring to an organization's efficiency and manageability.

**Problem domain:** Organizations encountering document management problems influencing their effectiveness and manageability, while executing ill-structured processes.

The perception and the solution of the problem situation in case 4, showed to be sufficient to solve HSLS's document-related problems. Consequently, it is concluded that the way of thinking presented in section 6.3.2 is appropriate for problems which are part of the problem domain.

The way of thinking is based on a multi-disciplinary view on electronic document management, containing an archival, organizational and technological perspective. It is important to notice that archival principles, such as 'provenance' and 'respect for original order' merely result in some document attributes, whereas in managing paper documents these principles have a much greater impact, such as influencing the physical location of documents. This illustrates the reduction of archival principles, such as 'respect for original order' and 'provenance', to one minor ability of an electronic document infrastructure. Principles relating to the determination of a document's value, however, remain of importance. This stresses the point made in Biza [1991 p.66], which advocates the integration of archival concepts with concept used in the area of information systems.

*Way of working*

The way of working proposed in the methodology for designing electronic document infrastructures, is closely related to the problem solving cycle. Conceptualization, specification, solution finding, and implementation are distinguished. Implementation is outside the scope of the proposed methodology.

The way of working is characterized by a middle-out approach, resulting in a rough and a detailed design. Organizational processes, perceived as described in chapter 2, are the starting point for composing these designs. These are used as a vehicle to communicate with stakeholders about the problem situation and possible solutions. These designs evolved during the execution of the problem cycle, continuously studying the details of both the problem situation and the design of a solution in depth. The phases of specification and solution finding were repeated three times until the designs became final for implementation. Due to organizational developments influencing the problem situation, the designs are adjusted. Case 4 showed that it is difficult, if not impossible, to control each factor which influences the problem situation. This emphasizes the importance to search for a sufficient instead of an optimal solution.

*Way of modeling*

The way of modeling presented in chapter 6 includes a process tree, a document tree and a prototype. Composing a process tree proved to be very important in the HSLs case, stimulating a discussion about the dominant way of making documents accessible. Furthermore, it stimulated the discussion about the universal character of the electronic document infrastructure and the way process control is implemented within HSLs. The document tree as such is not constructed in the HSLs case. A beginning was made, but after the variety of documents became clear, and the document types were listed, no attention was paid to the document tree. Instead of an enumerative listing of existing documents, the document types are important to the design of the electronic document infrastructure. Finally, the prototype showed to be of great importance to make document users participate in the project and illustrate the abilities of the electronic document infrastructure.

*Way of controlling*

The way of controlling should ensure the final design of the electronic document infrastructure to sufficiently solve the problem situation. The methodology for designing electronic document infrastructures pays attention to user participation and receiving approval of different stakeholders. The

HSLs case showed that the involvement of stakeholders changed during the design of the electronic document infrastructure. Structuring design issues in a rough and a detailed design helped to make the right proposals to the right stakeholder during the accurate phase in the project.

Due to its infrastructural character, an electronic document infrastructure will influence each workplace in the organization. Consequently, the project of designing an electronic document infrastructure will have interfaces with other projects in the organization influencing workplaces. In the HSLs case, for instance, this was the 'house style'-project and the 'configuration management'-project. The HSLs case showed that it is important to disconnect these projects, in order to reduce the complexity of designing an electronic document infrastructure.

An infrastructure is expected to outlive document manipulation applications. Consequently, it is important to anticipate on future organizational developments in designing an electronic document infrastructure. This is partly integrated with the design approach. An example of the latter is the formulation of an universal principle of process control which enabled the introduction of configuration management. Partly, the anticipation will have to be arranged by interviewing the people who share a view on future organizational developments. Furthermore, in decision making future organizational developments are to be taken into account. For instance, the latter occurred in selecting an appropriate tool to implement HSLs's electronic document infrastructure. The choice for the tool also enabled the implementation of configuration management.

### **8.5 The research approach**

Designing an electronic document infrastructure represents a new and complex problem. Little knowledge existed regarding designing electronic document infrastructures. Hence, the research approach needed to be exploratory, focusing on building a new body of knowledge regarding designing electronic document infrastructures. An inductive-hypothetical research approach is, therefore, used to conduct the research. Three inductive case studies are conducted: the Individual Rent Subsidy-case, the Investigation Service-case, and the Department of Spatial Planning-case. These cases are used to study the problems of document management in its natural setting. Each case study contains a design for document management. These designs are tested, not implemented. Based on the results of these case studies, a theory is constructed and presented as a methodology for designing electronic document infrastructures. The theory is

applied in a fourth case study: the case of the Project Organization High Speed Line South. This case resulted in a design for an electronic document infrastructure which is implemented. Action research was employed in this case, while the three inductive cases employed case study research.

Chapter 2 contains a number of reasons explaining why an inductive-hypothetical research approach is applicable to new and complex problems. One of the reasons is that it permits feedback and learning in one research cycle, enabling the evaluation of ideas regarding the working mechanisms in the problem area. This is implemented in the research approach by conducting a number of inductive cases prior to designing a new theory. This showed to be of great value in this research. HSL's management valued gaining general knowledge of the problem situation they encountered. Furthermore, they valued gaining a number of design principles to direct the search for solutions. These provided HSL with enough confidence to start a project for designing an electronic document infrastructure. The general knowledge of the problem situation and the design principles were based on the three inductive cases.

Using case studies as a research instrument includes a risk regarding the possibility of generalizing the research findings [Yin 1990]. In the first place, the research findings relate to the case studies conducted. The liberty is taken, however, to discuss the research findings in a broader sense than merely the case studies conducted. The cases used to build a theory for designing an electronic document infrastructure, contain different types of organizational processes. Furthermore, these case studies are conducted in an organization different from the organization used for theory testing.

## **8.6 Further research**

An electronic document infrastructure does not solve the problem of long term retention of electronic documents. By managing electronic documents, and registering the applications by which they are manipulated, instead of solving the problem of document retention, the problem is easier to deal with. For instance, the possibility of automatic conversion can be applied. It may prove to be valuable to investigate how to deal with the problem of retention when documents are managed by an electronic document infrastructure.

An electronic document infrastructure influences task execution by employees. Employees, particularly professionals executing goal-oriented processes, are free in managing their electronic documents. Until now, this area of task execution is not controlled. An electronic document

infrastructure reduces the freedom of employees regarding document management. It makes organizations more transparent. This might evoke a reaction of employees. This did not occur in the HSLs case. The relation between document management and the organization's objectives are clear. In this respect, HSLs is a rather homogeneous organization. This is also stressed by the possibility of identifying a general principle for process control. Investigating the question whether designing an electronic document infrastructure for less homogeneous organizations requires a different approach, may prove to be interesting.



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## Appendix A. Data collection

### A.1 Case individual rent subsidy program

To collect the data for this case study documentation was studied, a number of people were interviewed and the present author was enabled to make use of information of the statistical department of HIS.

The documentation studied is listed in the references. Additional information is used, for instance a so-called 'starters' packages'. Each new employee of HIS receives an information package. This package provides information concerning the actual IRS program, the policy of HIS and its consequences regarding the process, important circulars, and information concerning internal and external procedures. Furthermore, the package contains information regarding the organizational structure of HIS and the forms used in the IRS program.

A number of semi-open interviews were conducted with the following organizations and departments:

housing corporations: Zoetermeer, Leiden, Oegstgeest, Den Haag;  
municipalities: Zoetermeer, Leiden, Oegstgeest, Den Haag;  
HIS department: group leaders of task groups A and B, automation  
department and statistical department.

The information provided by the group leader of the task group B was checked with two other group leaders of the groups C and D by telephone.

The statistical department of HIS gathers information regarding the IRS program, both related to the actual process and its output. This department was consulted in order to determine the amount of time used to perform certain activities and to gain insight into the number of applications received throughout the year.

The findings of the research were described in a project report which was presented to and discussed with the management of the HIS department.

### A.2 Case Investigation Service

This case was conducted by a master-student under the supervision of the author and dr. K. van der Meer. The data were collected by the student. Jong [1995] offers a detailed description of the case. The collected data are structured in accordance with the framework presented in chapter 2 of this thesis.

The data are collected by means of documentation, interviews and co-working, during a period of 7 months. Documents used are summarized in the list of references. People responsible for the following organizational functions were interviewed:

- the general manager of the Investigation Service;

- the manager of the office management;
- an inspector, who is also a regional head;
- an employee responsible for policy staff;
- an employee of the IT staff;
- two investigators;
- two employees of the records keeping unit;
- four employees of the secretarial office.

The aim of the master student's project was selecting a supporting EDM-tool and testing it in a pilot-project. The findings of the student were presented to and discussed with the Investigation Service.

### **A.3 Case department of spatial planning**

To collect the data for this case study documentation was studied and a number of interviews were conducted. During a period of four months the author frequently visited the DSP, directorate Management and Support. This was executed in co-operation with the adjunct-secretary of the management and the secretary of the governmental spatial planning committee.

The following people were interviewed:

- dhr. v.d. Berg, hoofd Interne Zaken (BO/IZ);
- dhr. R. Dubar, hoofd Archief (BO/IZ);
- drs. F. Frederiks, plaatsvervangend hoofd afdeling Algemene Coördinatie (BO/AC);
- drs. D.J. Martin, secretaris Internationaal (BO/AC);
- drs. J.P. Menger, hoofd afdeling Algemene Coördinatie (BO/AC);
- drs. A.A.M. Meuleman, hoofd afdeling Landelijke Gebieden (UCB/LG);
- ir. H.J. Puylaert, projectleider Ruimpad (ROP);
- drs.ing. R.J. Schoonman, plv. secretaris Planologische Commissie (BO/AC);
- drs. P.J.A.M. Smeets, projectleider Landelijke Gebieden en Europa (ROP).

An inventory was made involving the 1993-document repository of the management and the governmental spatial planning committee [Uijlenbroek 1994].

### **A.4 Case Project Organization High Speed Line South**

Initially, HSLs gave an assignment to ODRP facilitair bv, a consultancy firm, to solve their document-based problems by using information technology. ODRP was expected to present HSLs with a design and a working pilot. At that time, ODRP had no suitable tool available for implementing a design in a pilot project. They had, however, a great amount of knowledge on document management. Consequently, a suitable tool had to be selected which fitted the design. After a search for appropriate IT tools, Betagraphics bv was subcontracted by ODRP facilitair bv. Betagraphics bv provided the tools for implementing the electronic document infrastructure and took care of software development. ODRP facilitair bv took care

of managing the project and designing the electronic document infrastructure. Using the vocabulary of the proposed design approach, ODRP facilitair bv focused on the global design, while Betagraphics bv focused on the detailed design.

When ODRP was given the assignment, the author was an employee of both ODRP and Delft University of Technology. The assignment provided an opportunity to test the design approach for the electronic document infrastructure, using action research. The author was the project manager of the project until the pilot became operational, after which the project was handed over to HSLs.

#### *Project structure*

The project was executed under control of the general IT steering committee of HSLs. This committee is responsible for the use of IT by the HSLs. The project manager reported to the steering committee. Two task groups were established, the document management task group and the pilot group. The project manager was the chairman of both groups.

The document management task group had the following members:

- C. Dijkerman, HSLs, document manager;
- R. ten Hove, systems engineer, Betagraphics bv;
- B. Lange, HSLs, IT system controller;
- W. Snijders, manager design-team 4;
- R. Smeets, HSLs, IT system controller;
- J. Uijlenbroek, chair, ODRP facilitair bv;
- D. Zijp, HSLs, manager quality control;
- G. Zwagerman, ODRP facilitair bv, substituted by G. Lodder, ODRP facilitair bv.

The pilot group included every member of design team 4 and a number of people who also joined the document management task group.

The document management task group was responsible for the design and implementation of the electronic document infrastructure. The pilot group used the designed system. Consequently, the pilot group was strongly involved in the detailed design. The project structure described was changed after the second prototype became operational.

*DESIGNING ELECTRONIC DOCUMENT INFRASTRUCTURES*

## Appendix B. Background information IRS case

### B.1 Activity structure

Each organization of the primary chain supplied a few people who were interviewed (see appendix A.1). Based on these interviews the IRS process is structured. The process and activity structure is presented to and discussed with people taking part in the IRS process.

### Activity structure of housing corporations

For each activity of figure 3.4 an activity structure is drawn up. Due to this thesis being confined to the primary organizational chain, only the activities of the processes (A) 'processing continuations' and (B) 'processing new applications' are shown in this appendix. The following activities are structured:

- making an appointment;
- filling in the form;
- implementing rent moderation;
- forwarding to municipality;
- determining IRS qualification;
- asking for approval.

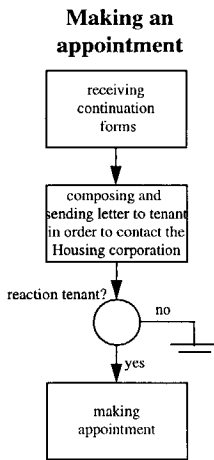


Figure b.1 Activity making an appointment

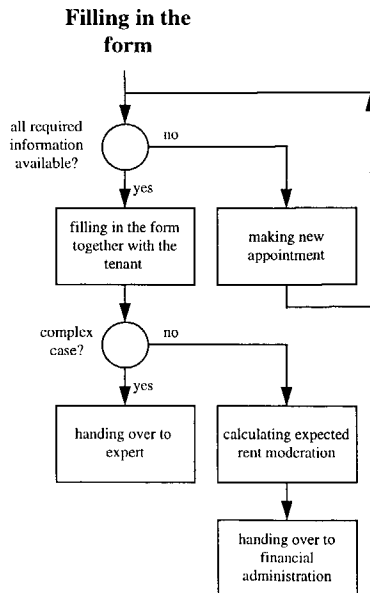


Figure b.2 Activity filling in the form

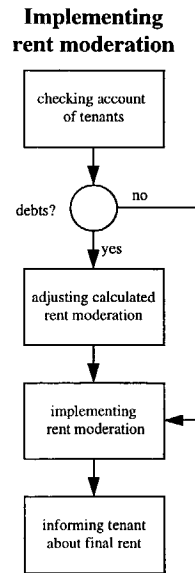


Figure b.3 Activity implementing rent moderation

The organizational chain of figure 3.3 shows which documents are exchanged between organizations. The process structure of figure 3.4 shows the processing of these documents by housing corporations. Figure 3.4 lists the documents exchanged within a housing corporation regarding the IRS program. The manipulation or treatment of these documents is shown in figure b.1 to b.6.

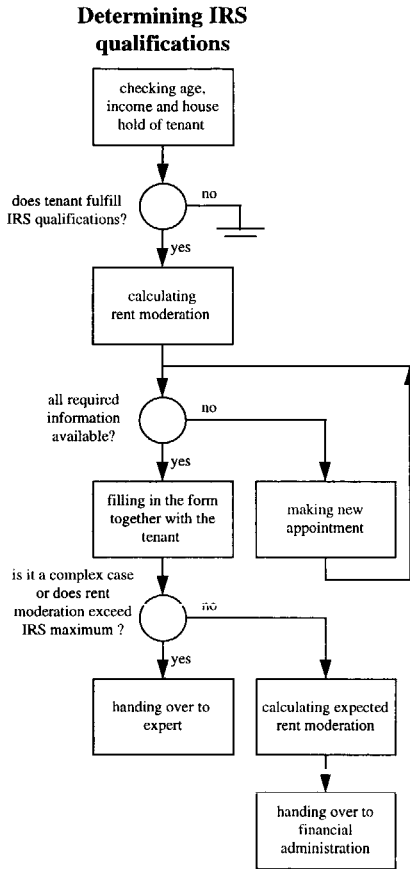


Figure b.4 Activity determining IRS qualifications

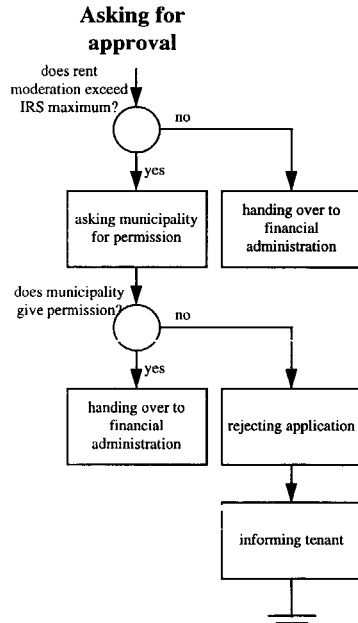


Figure b.5 Activity asking for approval

**Forwarding to municipality**

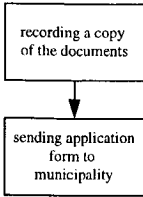


Figure b.6 Activity forwarding to municipality

**Activity structure of municipalities**

For each activity of figure 3.5 an activity structure is drawn up, which is shown in figure b.7 to figure b.9. The following activities are structured:

- performing checks;
- filling in the form and perform checks;
- implementing subsidy.

**Performing checks**

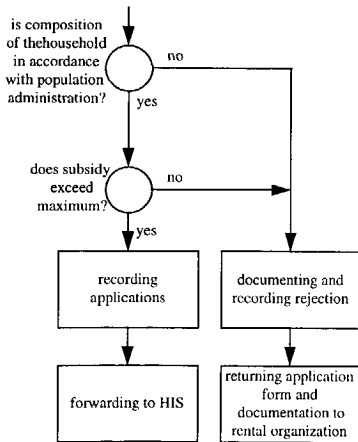


Figure b.7 Activity performing checks

**Filling in the form and perform checks**

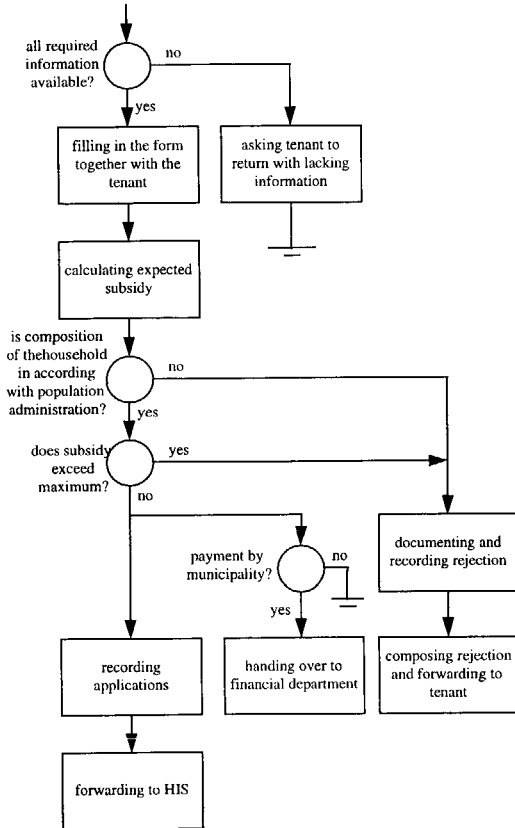


Figure b.8 Activity filling in the form and perform checks

**Implementing subsidy**

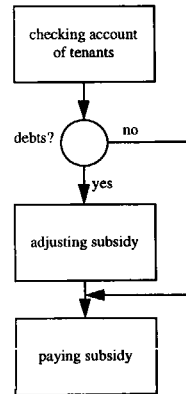


Figure b.9 Activity implementing subsidy

Comparing the two processes of figure 3.5 and the activity structures will reveal the fact that these processes are almost identical. In large municipalities these processes exist separately, whereas smaller municipalities have combined these processes into one process. The latter case involves a few employees in processing IRS applications. Unlike housing corporations, municipalities do not differ between continuations and new applications. These processes are executed as often as municipalities receive applications from rental organizations or as tenants apply to the municipality for IRS.

**Activity structure of the HIS department**

For each activity of figure 3.6 an activity structure is drawn up. Due to this research being confined to the primary organizational chain, only the activities of process A,



processing applications, are shown in figure b.10 to figure b.14. The following activities are structured:

- sorting applications regionally;
- archiving disposition;
- drawing up disposition;
- registering and checking;
- solving problems.

**Registering and checking**

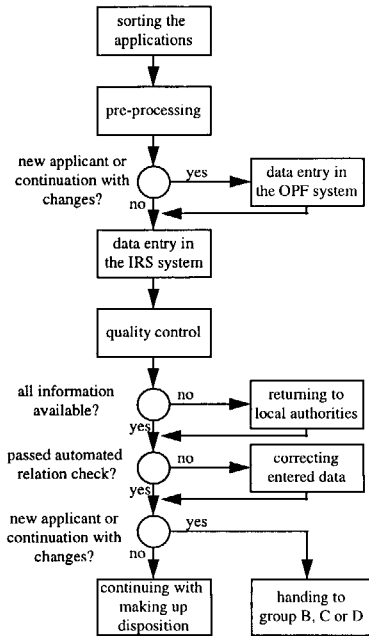


Figure b.10 Activity registering and checking

**Solving problems**

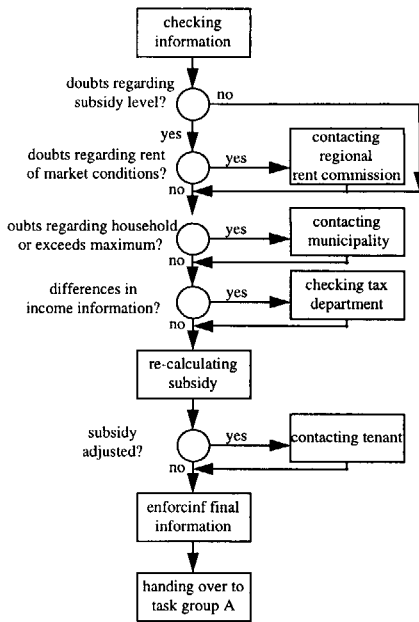


Figure b.11 Activity solving problems

**Sorting applications regionally**

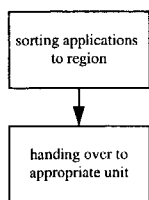


Figure b.12 Activity sorting applications regionally

**Archiving disposition**

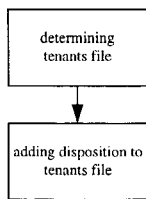


Figure b.13 Activity archiving disposition

**Drawing up disposition**

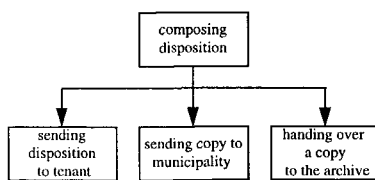


Figure b.14 Activity drawing up disposition

**B.2 Modification of documents within municipalities and HIS**

Figure 3.7 provides an overview of the document exchanged within the primary chain. Figure 3.7 only applies to documents used by the housing corporations. The table below completes figure 3.7 by listing the documents used by the municipalities and the HIS department.

<b>municipality</b>			
<b>checking applications</b>			
	completed application		from h.corp.
	copy of evidential documents		from h.corp.
	rejected application	o: IRS unit	to h. corp.
	accepted application	o: IRS unit	to HIS
	report of rejected application	o: IRS unit	to h.corp.
<b>processing new applications submitted directly by tenants</b>			
	blank application form		from HIS
	proposed rent subsidy	o: IRS unit d: fin. dep.	to tenant
	copy of evidential documents	o: IRS unit	to municip.
	completed application form	o: IRS unit	to municip.
<b>implementing subsidy</b>			
	proposed rent subsidy	destroyed	
<b>HIS department</b>			
<b>processing applications</b>			
	completed and checked appl.		from municip.
	disposition	o: task grp. A	to tenant to municip.
	badly completed application	o: task grp. A	to municip.
	request for rent information	o: tg. BCD	to rent.comm.
	report about rent information		from rent.c.
	request for info. about household	o: tg. BCD	to municip.
	report composition of household		from municip.
	request for income information	o: tg. BCD	to tax dep.
	report about income information		from tax dep.
	report of changes in continuation	o: task grp. A d: tg. BCD	
	final content of the disposition	o: tg. BCD d: task grp. A	

Figure 3.8 shows the modification of documents within housing corporations with respect to the process and activity structure. Similar to figure 3.8 the tables below show the document modification within municipalities and HIS.

APPENDIX B. BACKGROUND INFORMATION IRS CASE

Process	Activity	Document	Modification
<b>checking applications</b>			
	performing checks	completed application	checking information making copy recording receiving
		copy of evidential information	making copy
		rejected application	adding information regarding the rejection
		accepted application	adding signature forwarding to HIS recording forwarding
		report of rejected application	composing recording sending
<b>processing new applications submitted directly by tenants</b>			
	filling in the form and performing checks	blank application form	adding information
		copy of evidential information	collecting
		completed application form	adding information recording forwarding
		proposed rent subsidy	composing
	implementing subsidy	proposed rent subsidy	using information destroying

*Document modification within municipalities*

Process	Activity	Document	Modification
<b>processing applications</b>			
	sorting applications regionally	completed and checked application	sorting forwarding to tg. A
	registering and checking	completed and checked application	sorting using information forwarding to tg. B, C or D
		poorly completed application	recording returning to municipality
		report of changes in continuation	composing forwarding to tg. B, C or D
		solving problems	request for rent information
	solving problems	report about rent information	using information
		request for info. about household	composing
		report composition of household	using information
		request for income information	composing
		report about income information	using information
		report of changes in continuation	composing forwarding to task group A
		final content of the disposition	composing forwarding to task group A
	drawing up disposition	disposition	composing recording sending to tenant sending copy to municipality
	archiving disposition	disposition	recording

*Document modification within HIS*

### B.3 List of documents processed by HIS during 1994

The table below shows the number and type of documents processed by HIS during 1994. The last column denotes if the exchange of documents due to deviations in the data used by organizations involved in the primary chain (see section 3.5.1).

abbr.	type of document	sender	number	%	
DGVH	information of the department of housing	department of housing	293	0,17%	no
IB60	written statement of the tax department	tenant	1395	0,83%	yes
R59	deviations in the amount of subsidy	tenant	5530	3,27%	yes
SOFI	written statement regarding a social security number	tax department	2267	1,34%	yes
Aroba	arob notice of objection	tenant	372	0,22%	no
Arobi	information regarding a notice of objection	tenant	660	0,39%	yes
Arz	request for information	Investigation Service	682	0,40%	yes
Avb	AVB	tenant	17280	10,23%	yes
Awba	administrative law procedure (alw)	tenant	2611	1,55%	no
Awbi	information regarding alw	tenant	5347	3,16%	no
Bv	statement regarding the living situation of tenants	municipalities	1319	0,78%	yes
Cf	correction forms	housing corporation/tenant	17288	10,23%	yes
Ffp	statement regarding the financial situation of tenants	tax department	6780	4,01%	yes
Hc	market information	regional rent	9559	5,66%	yes
His15	information based on the GBA	municipalities	6076	3,60%	yes
His5	information regarding the family situation	tenant	3777	2,24%	yes
Icp	lcp	tenant	17371	10,28%	yes
IH11	notice of removal	housing corporation	130	0,08%	yes
Mim	authorization	tenant	29353	17,37%	no
Nc	payments afterwards	housing corporation	8022	4,75%	no
Norm	request for information	ombudsman	37	0,02%	no
Ovb	Ovb	tenant	3213	1,90%	no
Over	Other	other	14479	8,57%	yes
Rob	returned decisions	postal services	24	0,01%	no
Top	refund of subsidy	housing corporation /tenant	54	0,03%	no
Va	receivable of tenants	tenant	5038	2,98%	no
Vhb	receivable of housing corporations	housing corporation	1401	0,83%	no
Vs	request for an advanced payment	housing corporation	45	0,03%	no
Vvab	Vvab		5	0,00%	no
Vvas	Vvas		5473	3,24%	no
Vvtc	Vvtc		8	0,01%	no
Vvvc	Vvvc		3087	1,83%	no
		Total	168976		

#### R 4 Description of alternatives

Figure 3.15 shows a number of alternatives for the existing IRS process. This appendix provides a description of these alternatives. Since the aim of this case study was to gain more insight into document use, we did not focus on the evaluation of alternatives.

The following alternatives are summarize in figured 3.15:

##### *Stop having a fixed subsidy year*

The problem concerning the peak of applications at the start of a subsidy year is solved this alternative. Currently, the subsidy year is tuned with the determination of the rent. In May, the Ministry of Housing sets the policy regarding the rent levels. Dropping the fixed subsidy year will increase the complexity of the calculation of the

amount of subsidy. Consequently, one has to take notice of the change of rent during the subsidy period.

*Allowing housing corporations and the Ministry direct access to the GBA*

The automated population administration (GBA) contains a decentralized structure. Each municipality keeps local track of personal details. Local systems are connected in a national closed network which enables the exchange of personal information to those admitted to the network. GBA uses structured electronic data interchange. Admitting the housing corporations and HIS to the GBA will enable them to perform the checks which are currently performed by municipalities. Hence, municipalities can be withdrawn from the organizational chain.

*Add an IRS indication to the GBA*

GBA offers its connected organizations the possibility to generate notices of change. To make this possible a so-called indication has to be added to the personal records. By employing an IRS indication, the HIS department will automatically be informed regarding any change in a tenant's living situation. This allows HIS to respond efficiently regarding the subsidy paid.

*Allowing both housing corporations and municipalities direct access to the system of the tax-department*

Currently, only HIS has access to tax information. When allowed access, housing corporations and municipalities can check the income information supplied by tenants. This will reduce the number of non-smooth applications at HIS.

*Providing housing corporations and municipalities with information regarding sources of applicants*

In case the previous alternative is too difficult to implement due to technological and organizational grounds, this is a less extreme alternative. It seems that problems regarding the income information especially occur in case tenants have more than one source of income (e.g. several retirement funds). Supplying information regarding the number of sources of income facilitates the determination, in case a tenant fails to mention all sources.

*Allowing housing corporations and municipalities direct access to the HIS-system*

The final decisions on applications are made by HIS. A copy of the disposition informs housing corporations and municipalities about these decisions. The disposition is processed by housing corporations and municipalities in order to tune their data with the data of HIS. By allowing housing corporations and municipalities direct access to the HIS system, information can be implemented, and their systems can be tuned automatically. Allowing housing corporations and municipalities to enter data directly into the HIS system, one takes this alternative one step further.

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### *Decentralizing the IRS operations to municipalities or housing corporations*

HIS checks supplied information and decides on applications. By decentralizing the IRS operations to municipalities or housing corporations, the number of documents exchanged with HIS will strongly decrease. This alternative requires a change of law. It will change the role of HIS from an executing department into an inspection department.

### *Prolonging the subsidy in case there are no changes of information reported*

The large number of continuations at the beginning of the subsidy year can be decreased by automatically prolonging the subsidy in case no changes in the living situation (GBA) and the income (tax department) are reported.

### *Sending a copy of the change of address to HIS and municipalities*

Housing corporations hold the most updated information regarding tenants' living addresses. In case of a move, a tenant or a housing corporation could send a notice to municipalities and HIS. This will update their data.

### *Informing housing corporations and municipalities regarding established differences in supplied information*

In case HIS notices differences between their information and the information supplied by tenants, they should inform municipalities and housing corporations. This will enable municipalities and housing corporations to adjust the rent moderation and the rent paid as soon as possible, reducing the amount of money to be resolved.

### *Using EDI between housing corporations and municipalities*

Using EDI between housing corporations and municipalities, and the Ministry. This alternative eliminates re-entering of data.

### *Preprocessing applications by the ministry before the final policy is set thereby, reducing the number of applications in store*

This alternative is discussed in section 3.3.2.

## Appendix C. Background information DSP case

The figure below shows the number of documents each division of the DSP delivered to the management for decision making. It shows which divisions wrote the documents of category E, figure 5.7.

Abbreviation	Division	Number
CV/DVEB/PP	VROM	2
DGM	VROM - Directoraat Generaal Milieubeheer	2
RGD	VROM - Rijksgebouwendienst	1
Total ministry, not DSP		5
RPD/BO	RPD - Bestuur en Ondersteuning	19
RPD/BO/AC	RPD - Bestuur en Ondersteuning - Algemene Coördinatie	57
RPD/BO/B	RPD - Bestuur en Ondersteuning - Bestuursaangelegenheden	2
RPD/BO/FEZ	RPD - Bestuur en Ondersteuning - Financiële en Economische Zaken	12
RPD/BO/IZ	RPD - Bestuur en Ondersteuning - Interne Zaken	1
RPD/BO/P&O	RPD - Bestuur en Ondersteuning - Personeel en Organisatie	26
Total BO		117
RPD/ROP	RPD - Ruimtelijk Onderzoek en Planning	16
RPD/ROP/IV	RPD - Ruimtelijk Onderzoek en Planning - Informatievoorziening	1
RPD/ROP/LV	RPD - Ruimtelijk Onderzoek en Planning - Landschapsvorming	1
RPD/ROP/O	RPD - Ruimtelijk Onderzoek en Planning - Onderzoek	4
RPD/ROP/P	RPD - Ruimtelijk Onderzoek en Planning - Planning	6
RPD/ROP/SV	RPD - Ruimtelijk Onderzoek en Planning	3
RPD/ROP/SVP	RPD - Ruimtelijk Onderzoek en Planning	1
Total ROP		32
RPD/UCB	RPD - Uitvoering en Coördinatie Ruimtelijk Beleid	9
RPD/UCB/IM	RPD - Uitvoering en Coörd. Ruimtelijk Beleid - Investerings en Milieu	7
RPD/UCB/LG	RPD - Uitvoering en Coörd. Ruimtelijk Beleid - Landelijke Gebieden	17
RPD/UCB/ROB	RPD - Uitv. en Coörd. Ruim. Beleid - Regionaal Ontwikkelingsbeleid	11
RPD/UCB/SI	RPD - Uitvoering en Coördinatie Ruimtelijk Beleid	19
RPD/UCB/SI/proj.	RPD - Uitvoering en Coördinatie Ruimtelijk Beleid	8
Total UCB		71
	Author unknown	16
Total category E	Policy papers	241

*Number of policy papers delivered by divisions in 1993*

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### Appendix D. Questionnaire HSLs case and results

Questions and results are jointly presented. A six point Lickert scale is used, ranging from 0 to 5. The *t*-test is calculated using a significance level of  $\alpha = 0,05$  and  $n_1 = 9$  and  $n_2 = 7$ . Consequently,  $t_{0,025}(14) = 2,145$ . An asterisk (\*) next to a table denotes a significant difference between the first and the second measurement. The significance of a difference between the first and the second measurement is calculated using:

$$\bar{X}_1 = \frac{\sum_{i=1}^{n_1} X_{1,i}}{n_1} \quad \bar{X}_2 = \frac{\sum_{i=1}^{n_2} X_{2,i}}{n_2} \quad d = \bar{X}_1 - \bar{X}_2 \text{ and}$$

$$S_d = \sqrt{\frac{S_1^2(n_1 - 1) + S_2^2(n_2 - 1)}{n_1 + n_2} \left( \frac{1}{n_1} + \frac{1}{n_2} \right)}$$

There is no significant difference between  $\bar{X}_1$  and  $\bar{X}_2$  if:

$$d - S_d \times t_{0,025}(n_1 + n_2 - 2) < 0 < d + S_d \times t_{0,025}(n_1 + n_2 - 2)$$

In the tables presenting the results  $R_1 = d - S_d \times t_{0,025}(n_1 + n_2 - 2)$  and  $R_2 = d + S_d \times t_{0,025}(n_1 + n_2 - 2)$ .

In each of the questions the Lickert scale has the following meaning:

- 0 = never;
- 1 = less than once a month; 2 = less than once a week;
- 3 = less than once a day; 4 = less than 5 times a day; 5 = more than 5 times a day;

#### Question 1 and results

Which application do you use and how often does this occur?

Applications	Measurement 1							Measurement 2							t-test									
	1	2	3	4	5	6	7	8	$\bar{X}_1$	$S_1^2 \times 8$	1	2	3	4	5	6	7	8	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	<i>d</i>	$R_1$	$R_2$
Access	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AutoCad12	5	4	0	0	0	0	0	0	1	32	5	4	0	0	0	0	0	1,29	29,4	1,06	-0,3	-2,6	1,98	
CadOverlay	3	2	0	0	0	0	0	0	0,56	10,2	3	1	0	0	0	0	0	0,57	7,71	0,57	-0	-1,2	1,21	
Dbase	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Drawperfect	3	0	0	0	0	0	0	0	0,33	8	0	0	0	0	0	0	0	0	0	0,38	0,33	-0,5	1,15	
Email	5	5	3	3	3	2	2	0	2,56	26,2	5	4	4	4	3	2	0	3,14	16,9	0,88	-0,6	-2,5	1,31	
Excel	5	5	4	4	1	0	0	0	2,11	42,9	4	4	3	2	2	2	0	2,43	11,7	1	-0,3	-2,5	1,82	
Lotus123	2	1	0	0	0	0	0	0	0,33	4	0	0	0	0	0	0	0	0	0	0,27	0,33	-0,2	0,91	
Moss	4	0	0	0	0	0	0	0	0,44	14,2	5	0	0	0	0	0	0	0,71	21,4	0,8	-0,3	-2	1,46	
MS Word	5	3	2	0	0	0	0	0	1,11	26,9	5	5	5	4	3	0	0	3,14	30,9	1,02	-2	-4,2	0,16	
Perfectview	4	4	3	3	0	0	0	0	1,56	28,2	5	4	4	3	2	0	0	2,57	23,7	0,97	-1	-3,1	1,07	
Solaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Wordperfect	5	5	5	4	4	4	3	1	4	14	5	4	2	1	0	0	0	1,71	25,4	0,85	2,29	0,47	4,1 *	
Timeline	4	0	0	0	0	0	0	0	0,44	14,2	4	0	0	0	0	0	0	0,57	13,7	0,71	-0,1	-1,7	1,4	
Others	3	0	0	0	0	0	0	0	0,33	8	2	0	0	0	0	0	0	0,29	3,43	0,46	0,05	-0,9	1,02	

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Question 2 and results

Which types of paper document do you use and how often does this occur?

Document types	Measurement 1								Measurement 2						t-test										
	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$S_1^2 \times 8$	1	2	3	4	5	6	7	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	$d$	$R_1$	$R_2$	
Policy reports	3	2	2	2	1	1	1	1	0	0	1,33	8	4	2	2	1	0	0	0	1,29	13,4	0,62	0,05	-1,3	1,38
Calculations	4	3	3	3	2	1	0	0	0	0	1,78	19,6	5	4	3	3	3	0	0	2,57	21,7	0,87	-0,8	-2,6	1,06
Formal letters	4	4	3	3	3	2	2	2	2	2	2,89	4,89	4	3	3	3	3	3	3	3,14	0,86	0,32	-0,3	-0,9	0,44
Input documents	4	3	3	3	2	1	1	0	0	0	1,89	16,9	4	3	2	0	0	0	0	1,29	17,4	0,79	0,6	-1,1	2,3
Internal orders	4	3	3	3	2	2	1	0	0	0	2	16	5	3	2	2	0	0	0	1,71	21,4	0,82	0,29	-1,5	2,05
Maps	5	4	3	3	3	2	2	0	0	0	2,44	22,2	4	3	3	3	2	0	0	2,14	14,9	0,82	0,3	-1,5	2,06
Memos	5	4	4	3	3	3	2	2	0	0	3,22	7,56	4	4	3	3	3	0	0	2,86	10,9	0,58	0,37	-0,9	1,6
Projectplan	4	3	3	3	3	2	1	0	0	0	2,11	16,9	3	3	2	1	0	0	0	1,29	11,4	0,72	0,83	-0,7	2,36
Project assignm.	4	2	2	2	1	1	1	0	0	0	1,44	12,2	2	0	0	0	0	0	0	0,29	3,43	0,53	1,16	0,02	2,3
Reports	4	3	3	3	2	2	2	0	0	0	2,44	10,2	4	2	2	2	2	0	0	1,71	11,4	0,63	0,73	-0,6	2,07
Drawings	5	4	4	2	2	1	0	0	0	0	2	30	5	5	2	2	0	0	0	2	30	1,04	0	-2,2	2,24
Minutes, etc.	5	4	4	3	3	3	3	2	0	0	3,33	6	4	4	3	2	2	0	0	2,14	16,9	0,64	1,19	-0,2	2,57
Others	4	2	1	0	0	0	0	0	0	0	0,78	15,6	4	3	2	0	0	0	0	1,29	17,4	0,77	-0,5	-2,2	1,15

Question 3 and results

Which types of electronic documents do you use and how often does this occur?

Document types	Measurement 1								Measurement 2						t-test										
	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$S_1^2 \times 8$	1	2	3	4	5	6	7	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	$d$	$R_1$	$R_2$	
Policy reports	2	1	0	0	0	0	0	0	0	0	0,33	4	5	2	0	0	0	0	0	1	22	0,69	-0,7	-2,1	0,81
Calculations	4	3	3	2	0	0	0	0	0	0	1,33	22	5	3	3	2	0	0	0	1,86	22,9	0,9	-0,5	-2,5	1,41
Formal letters	4	3	3	2	2	2	1	0	0	0	1,89	14,9	4	4	3	3	2	0	0	2,29	17,4	0,77	-0,4	-2	1,25
Input documents	4	3	2	2	1	1	1	0	0	0	1,56	14,2	4	1	0	0	0	0	0	0,71	13,4	0,71	0,84	-0,7	2,36
Internal orders	1	1	1	0	0	0	0	0	0	0	0,44	2,22	3	1	0	0	0	0	0	0,57	7,71	0,42	-0,1	-1	0,78
Maps	3	0	0	0	0	0	0	0	0	0	0,33	8	5	4	0	0	0	0	0	1,29	29,4	0,82	-1	-2,7	0,82
Memos	4	4	3	3	3	2	2	1	0	0	2,44	14,2	5	4	3	3	2	0	0	2,43	21,7	0,81	0,02	-1,7	1,75
Projectplan	3	3	2	2	2	0	0	0	0	0	1,33	14	4	2	2	1	0	0	0	1,29	13,4	0,71	0,05	-1,5	1,56
Project assignm.	1	1	0	0	0	0	0	0	0	0	0,22	1,56	1	0	0	0	0	0	0	0,14	0,86	0,21	0,08	-0,4	0,53
Reports	3	2	1	1	0	0	0	0	0	0	0,78	9,56	4	1	0	0	0	0	0	0,71	13,4	0,65	0,06	-1,3	1,45
Drawings	5	0	0	0	0	0	0	0	0	0	0,56	22,2	5	5	0	0	0	0	0	1,43	35,7	1,03	-0,9	-3,1	1,33
Minutes, etc.	4	4	3	3	2	1	0	0	0	0	1,89	22,9	4	4	4	3	3	2	3	3,29	3,43	0,69	-1,4	-2,9	0,09
Others	4	2	0	0	0	0	0	0	0	0	0,67	16	5	3	3	3	2	2	0	2,57	13,7	0,73	-1,9	-3,5	-0,3

Question 4 and results

Which type of paper documents do you receive from a DT4 colleague and how often does this occur?

Document types	Measurement 1								Measurement 2						t-test										
	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$S_1^2 \times 8$	1	2	3	4	5	6	7	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	$d$	$R_1$	$R_2$	
Policy reports	3	2	1	1	0	0	0	0	0	0	0,78	9,56	2	1	0	0	0	0	0	0,43	3,71	0,49	0,35	-0,7	1,4
Calculations	3	2	2	0	0	0	0	0	0	0	0,78	11,6	4	3	0	0	0	0	0	1	18	0,73	-0,2	-1,8	1,35
Formal letters	3	1	1	1	1	0	0	0	0	0	0,89	6,89	3	3	3	0	0	0	0	1,29	15,4	0,64	-0,4	-1,8	0,97
Input documents	3	2	1	1	1	0	0	0	0	0	0,89	8,89	3	2	2	0	0	0	0	1	10	0,59	-0,1	-1,4	1,14
Internal orders	2	1	1	0	0	0	0	0	0	0	0,44	4,22	3	1	0	0	0	0	0	0,57	7,71	0,47	-0,1	-1,1	0,87
Maps	5	2	2	2	2	0	0	0	0	0	1,44	22,2	3	2	1	0	0	0	0	0,86	8,86	0,75	0,59	-1	2,2
Memos	3	2	2	1	1	1	0	0	0	0	1,22	7,56	3	2	2	2	1	0	0	1,43	7,71	0,53	-0,2	-1,3	0,92
Projectplan	2	2	1	1	1	0	0	0	0	0	0,89	4,89	1	0	0	0	0	0	0	0,14	0,86	0,32	0,75	0,05	1,44
Project assignm.	3	1	1	0	0	0	0	0	0	0	0,56	8,22	2	2	1	0	0	0	0	0,71	5,43	0,5	-0,2	-1,2	0,91
Reports	3	2	2	1	1	0	0	0	0	0	1,11	8,89	2	1	0	0	0	0	0	0,43	3,71	0,48	0,68	-0,3	1,71
Drawings	5	4	3	2	1	0	0	0	0	0	1,67	30	5	5	1	0	0	0	0	1,57	33,7	1,08	0,1	-2,2	2,4
Minutes, etc.	3	3	2	2	0	0	0	0	0	0	1,11	14,9	3	3	2	2	0	0	0	1,43	11,7	0,69	-0,3	-1,8	1,17
Others	0	0	0	0	0	0	0	0	0	0	0	0	5	2	1	0	0	0	0	1,14	20,9	0,62	-1,1	-2,5	0,18

APPENDIX D. QUESTIONNAIRE HSLS CASE AND RESULTS

Question 5 and results

Which types of *electronic* documents do you receive from a DT4 colleague and how often does this occur?

Document types	Measurement 1				Measurement 2				t-test																
	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$S_1^2 \times 8$	1	2	3	4	5	6	7	8	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	$d$	$R_1$	$R_2$
Policy reports	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calculations	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0,57	5,71	0,32	-0,6	-1,3	0,12
Formal letters	1	1	1	0	0	0	0	0	0,33	2	2	0	0	0	0	0	0	0,29	3,43	0,31	0,05	-0,6	0,72		
Input documents	1	1	0	0	0	0	0	0	0,22	1,56	1	0	0	0	0	0	0	0,14	0,86	0,21	0,08	-0,4	0,53		
Internal orders	1	1	0	0	0	0	0	0	0,22	1,56	0	0	0	0	0	0	0	0	0	0	0,17	0,22	-0,1	0,58	
Maps	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0,86	14,9	0,52	-0,9	-2	0,26			
Memos	3	2	1	0	0	0	0	0	0,67	10	2	1	0	0	0	0	0,43	3,71	0,5	0,24	-0,8	1,31			
Projectplan	1	1	0	0	0	0	0	0	0,22	1,56	1	0	0	0	0	0	0,14	0,86	0,21	0,08	-0,4	0,53			
Project assignm.	1	0	0	0	0	0	0	0	0,11	0,89	0	0	0	0	0	0	0	0	0	0	0,13	0,11	-0,2	0,38	
Reports	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drawings	3	2	0	0	0	0	0	0	0,56	10,2	5	4	0	0	0	0	1,29	29,4	0,85	-0,7	-2,5	1,09			
Minutes, etc.	2	1	0	0	0	0	0	0	0,33	4	1	1	0	0	0	0	0,29	1,43	0,31	0,05	-0,6	0,72			
Others	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0,71	9,43	0,41	-0,7	-1,6	0,17			

Question 6 and results

Which types of *paper* documents are not (immediately) available when needed, and how often does this occur?

Document types	Measurement 1				Measurement 2				t-test															
	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$S_1^2 \times 8$	1	2	3	4	5	6	7	8	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	$d$	$R_1$
Policy reports	2	2	1	1	0	0	0	0	0,67	6	3	2	1	0	0	0	0,86	8,86	0,52	-0,2	-1,3	0,92		
Calculations	1	1	1	0	0	0	0	0	0,33	2	3	3	0	0	0	0	0,86	12,9	0,52	-0,5	-1,6	0,59		
Formal letters	3	2	2	2	1	1	1	0	1,33	8	3	2	2	1	0	0	1,14	8,86	0,55	0,19	-1	1,38		
Input documents	3	2	1	1	1	0	0	0	1	8	3	2	0	0	0	0	0,71	9,43	0,56	0,29	-0,9	1,49		
Internal orders	1	1	1	0	0	0	0	0	0,33	2	4	1	0	0	0	0	0,71	13,4	0,53	-0,4	-1,5	0,75		
Maps	3	2	2	1	1	1	0	0	1,11	8,89	4	1	0	0	0	0	0,71	13,4	0,64	0,4	-1	1,76		
Memos	2	2	1	1	1	0	0	0	0,89	4,89	4	3	2	2	1	0	1,71	13,4	0,58	-0,8	-2,1	0,41		
Projectplan	2	1	1	1	1	0	0	0	0,78	3,56	3	1	0	0	0	0	0,57	7,71	0,45	0,21	-0,8	1,18		
Project assignm.	1	1	1	0	0	0	0	0	0,33	2	5	0	0	0	0	0	0,71	21,4	0,65	-0,4	-1,8	1,02		
Reports	2	2	2	1	1	1	0	0	1,11	4,89	3	1	1	0	0	0	0,71	7,43	0,47	0,4	-0,6	1,41		
Drawings	5	2	2	2	1	1	0	0	1,56	18,2	5	1	1	0	0	0	1	20	0,83	0,56	-1,2	2,34		
Minutes, etc.	2	2	2	2	2	1	0	0	1,44	6,22	4	3	2	2	1	1	1,86	10,9	0,56	-0,4	-1,6	0,78		
Others	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0,29	1,43	0,16	-0,3	-0,6	0,06		

Question 7 and results

Which types of *electronic* documents are not (immediately) available when needed, and how often does this occur?

Document types	Measurement 1				Measurement 2				t-test																
	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$S_1^2 \times 8$	1	2	3	4	5	6	7	8	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	$d$	$R_1$	$R_2$
Policy reports	3	2	1	1	1	0	0	0	0,89	8,89	1	0	0	0	0	0	0,14	0,86	0,42	0,75	-0,2	1,65			
Calculations	3	2	1	1	1	0	0	0	0,89	8,89	0	0	0	0	0	0	0	0	0	0	0,4	0,89	0,03	1,75	*
Formal letters	4	3	2	2	1	1	1	0	1,56	14,2	1	1	0	0	0	0	0,29	1,43	0,53	1,27	0,13	2,41	*		
Input documents	1	1	1	0	0	0	0	0	0,44	2,22	1	0	0	0	0	0	0,14	0,86	0,24	0,3	-0,2	0,81			
Internal orders	1	1	0	0	0	0	0	0	0,22	1,56	1	0	0	0	0	0	0,14	0,86	0,21	0,08	-0,4	0,53			
Maps	4	3	2	2	1	0	0	0	1,33	18	0	0	0	0	0	0	0	0	0	0,57	1,33	0,11	2,56	*	
Memos	3	3	2	1	1	1	0	0	1,33	10	1	1	0	0	0	0	0,29	1,43	0,46	1,05	0,07	2,02	*		
Projectplan	3	2	2	1	1	1	0	0	1,11	8,89	1	0	0	0	0	0	0,14	0,86	0,42	0,97	0,07	1,87	*		
Project assignm.	3	2	1	0	0	0	0	0	0,67	10	0	0	0	0	0	0	0	0	0	0,43	0,67	-0,2	1,58		
Reports	2	2	1	0	0	0	0	0	0,56	6,22	1	0	0	0	0	0	0,14	0,86	0,36	0,41	-0,4	1,18			
Drawings	5	2	2	1	0	0	0	0	1,11	22,9	1	0	0	0	0	0	0,14	0,86	0,66	0,97	-0,4	2,38			
Minutes, etc.	4	2	2	1	1	1	0	0	1,33	12	1	0	0	0	0	0	0,14	0,86	0,48	1,19	0,15	2,23	*		
Others	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0,14	0,86	0,12	-0,1	-0,4	0,12			

**Question 8 and results**

How often do you search for an electronic or paper document, and how long does this take?

The following search strategies were distinguished:

- Asking a roommate (e.g. do you have the document?)
- Obtaining information from a colleague by phone (e.g. do you know where the document is?)
- Obtaining information from somebody else, not being a colleague
- Browsing through your private repository
- Browsing through the repository of the design team
- Browsing through the private repository of a colleague.

If required, interviewees could add other search strategies.

Search strategy	Measurement 1								Measurement 2						t-test												
	$\bar{T}_1$	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$s_1^2 \times 8$	$\bar{T}_2$	1	2	3	4	5	6	7	$\bar{X}_2$	$s_2^2 \times 6$	$S_d$	$d$	$R_1$	$R_2$	
Roommate	3,7	4	4	3	3	3	2	1	1	1	2,44	12,2	4,5	3	1	1	0	0	0	0	0,71	7,43	0,6	1,73	0,45	3,01	*
Phone colleague	4,7	3	2	2	1	1	1	1	1	0	1,33	6	3,25	4	1	1	1	0	0	0	1	12	0,57	0,33	-0,9	1,56	
Phone somebody	7	1	1	1	1	1	1	0	0	0	0,67	2	2,3	3	3	1	0	0	0	0	1	12	0,5	-0,3	-1,4	0,75	
Own repository	5,4	5	5	4	4	3	3	3	2	1	3,33	14	2,6	4	3	2	2	1	0	0	1,71	13,4	0,71	1,62	0,11	3,13	*
Repository DT4	6,3	4	3	3	3	1	1	0	0	0	1,67	20	1	4	1	1	0	0	0	0	0,86	12,9	0,77	0,81	-0,8	2,47	
Repository coll.	6	3	2	2	2	1	1	0	0	0	1,22	9,56	1	4	1	0	0	0	0	0	0,71	13,4	0,65	0,51	-0,9	1,89	

Using  $\bar{T}_1$  and  $\bar{T}_2$  the difference in the mean time is tested.  $\bar{T}_1 = 5,52$  and  $\bar{T}_2 = 2,44$ . Consequently,  $S_1^2 \times 5 = 7,03$  and  $S_2^2 \times 5 = 9,09$ . Hence,  $S_d = 0,73$  and  $d = 3,08$ . The difference in process time is significant because  $R_1 = 1,5$  and  $R_2 = 4,65$ .

**Question 9 and results**

How often are you involved somebody else's search action and how long does this take?

The following ways of being involved were distinguished:

- Answering questions of a roommate;
- Answering questions of a colleague by phone;
- Answering questions of somebody, who is not a colleague, by phone;
- Browsing through your private repository on request of a colleague;
- Browsing through your private repository on request of somebody, who is not a colleague;
- Browsing through the repository of the design team on request of a colleague;
- Browse through the repository of the design team on request of somebody, who is not a colleague;
- Browsing through the private repository of a colleague on request of another colleague;
- Browsing through the private repository of a colleague on request of somebody, who is not a colleague.

If required, interviewees could add other ways of being involved.

APPENDIX D. QUESTIONNAIRE HSLS CASE AND RESULTS

Involvement	Measurement 1								Measurement 2						t-test											
	$\bar{T}_1$	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$S_1^2 \times 8$	$\bar{T}_2$	1	2	3	4	5	6	7	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	$d$	$R_1$	$R_2$
Roommate	4	4	3	3	3	2	1	1	1	0	2	14	2	3	2	1	0	0	0	0	0,86	8,86	0,64	1,14	-0,2	2,52
Phone collegue	3,3	3	3	2	2	1	1	1	0	0	1,44	10,2	2,3	3	2	2	0	0	0	1	10	0,61	0,44	-0,9	1,74	
Phone somebody	3,6	2	1	1	1	1	0	0	0	0,78	3,56	2	3	1	1	0	0	0	0	0,71	7,43	0,45	0,06	-0,9	1,02	
Private reposit.	5	4	3	3	2	2	2	2	1	1	2,22	7,56	2	3	2	1	0	0	0	0,86	8,86	0,55	1,37	0,19	2,54	
Idem on request	4,6	4	2	2	1	1	1	1	0	0	1,33	12	1	3	2	0	0	0	0	0,71	9,43	0,62	0,62	-0,7	1,96	
DT4 repository	5	4	2	2	1	1	0	0	0	1,11	14,9	1	4	0	0	0	0	0	0,57	13,7	0,72	0,54	-1	2,08		
Idem on request	6	4	2	1	1	1	0	0	0	1	14	1	4	0	0	0	0	0	0,57	13,7	0,71	0,43	-1,1	1,95		
Colleague's rep.	4,25	4	2	1	1	1	1	0	0	0	1,11	12,9	1	3	2	0	0	0	0	0,71	9,43	0,64	0,4	-1	1,76	
Idem on request	4,3	4	1	1	1	0	0	0	0	0,78	13,6	1	2	2	0	0	0	0	0,57	5,71	0,59	0,21	-1,1	1,47		

Using  $\bar{T}_1$  and  $\bar{T}_2$  the difference in the mean time is tested.  $\bar{T}_1 = 4,45$  and  $\bar{T}_2 = 1,45$ . Consequently,  $S_1^2 \times 8 = 5,34$  and  $S_2^2 \times 8 = 2,64$ . Hence,  $S_d = 0,33$  and  $d = 2,97$ . The difference in process time is significant because  $R_1 = 2,26$  and  $R_2 = 3,69$ .

Question 10 and results

How often do you create a new electronic document, and how long does it take to find the appropriate document identification and register the document?

Document type	Measurement 1								Measurement 2						t-test										
	$\bar{T}_1$	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$S_1^2 \times 8$	$\bar{T}_2$	1	2	3	4	5	6	7	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	$d$	$R_1$
Policy reports	3,25	2	1	1	1	0	0	0	0	0	0,56	4,22	3,5	3	3	1	1	0	0	1,14	10,9	0,52	-0,6	-1,7	0,53
Calculations	0	2	2	0	0	0	0	0	0	0	0,44	6,22	10	3	2	0	0	0	0	0,71	9,43	0,53	-0,3	-1,4	0,87
Formal letters	2,5	4	3	2	2	1	1	1	0	1,67	12	4,8	4	3	2	2	2	0	1,86	12,9	0,67	-0,2	-1,6	1,25	
Input documents	3	3	3	2	1	1	0	0	0	1,11	12,9	10	2	2	1	0	0	0	0,71	5,43	0,58	0,4	-0,8	1,63	
Internal orders	4	1	1	1	0	0	0	0	0	0,33	2	10	2	0	0	0	0	0	0,29	3,43	0,31	0,05	-0,6	0,72	
Maps	0	0	0	0	0	0	0	0	0	0	0	4	3	0	0	0	0	0	0,43	7,71	0,37	-0,4	-1,2	0,37	
Memos	2	4	3	3	3	3	2	1	0	2,44	12,2	5,5	5	3	2	2	0	0	1,71	21,4	0,78	0,73	-0,9	2,41	
Projectplan	3,2	2	2	1	1	1	1	0	0	0,89	4,89	4	2	1	1	0	0	0	0,57	3,71	0,4	0,32	-0,5	1,16	
Project assignm.	5	1	0	0	0	0	0	0	0	0,11	0,89	0	0	0	0	0	0	0	0	0	0	0,13	0,11	-0,2	0,38
Reports	2,5	2	2	1	1	1	0	0	0	0,78	5,56	1	3	1	0	0	0	0	0,57	7,71	0,49	0,21	-0,8	1,26	
Drawings	5	5	4	0	0	0	0	0	0	1	32	5	5	4	0	0	0	0	1,29	29,4	1,06	-0,3	-2,6	1,98	
Minutes, etc.	0,7	3	3	3	3	2	2	1	0	1,89	12,9	3,8	3	3	2	1	1	0	1,43	9,71	0,64	0,46	-0,9	1,83	
Others	0	0	0	0	0	0	0	0	0	0	0	3	1	1	1	0	0	0	0,43	1,71	0,18	-0,4	-0,8	-0,1	

Using  $\bar{T}_1$  and  $\bar{T}_2$  the difference in the mean time is tested.  $\bar{T}_1 = 3,07$  and  $\bar{T}_2 = 5,38$ . Consequently,  $S_1^2 \times 9 = 16,5$  and  $S_2^2 \times 11 = 99,2$ . Hence,  $S_d = 1,03$  and  $d = -2,32$ . The difference in process time is significant because  $R_1 = -4,53$  and  $R_2 = -0,11$ .

DESIGNING ELECTRONIC DOCUMENT INFRASTRUCTURES

Question 11 and results

How often do you store documents in the repository of the design team and how much time does this take?

Document types	Measurement 1								Measurement 2						t-test											
	$\bar{T}_1$	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$S_1^2 \times 8$	$\bar{T}_2$	1	2	3	4	5	6	7	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	$d$	$R_1$	$R_2$
Policy reports	1	1	1	0	0	0	0	0	0	0	0,22	1,56	--	0	0	0	0	0	0	0	0	0	0,17	0,22	-0,1	0,58
Calculations	2	3	0	0	0	0	0	0	0	0	0,33	8	--	0	0	0	0	0	0	0	0	0	0,38	0,33	-0,5	1,15
Formal letters	1,5	4	2	2	0	0	0	0	0	0	0,89	16,9	3	4	2	0	0	0	0	0	0,86	14,9	0,76	0,03	-1,6	1,66
Input documents	2	4	1	0	0	0	0	0	0	0	0,56	14,2	--	0	0	0	0	0	0	0	0	0	0,51	0,56	-0,5	1,65
Internal orders	1	1	1	1	0	0	0	0	0	0	0,33	2	--	0	0	0	0	0	0	0	0	0	0,19	0,33	-0,1	0,74
Maps	1	1	1	0	0	0	0	0	0	0	0,22	1,56	--	0	0	0	0	0	0	0	0	0	0,17	0,22	-0,1	0,58
Memos	2	4	1	0	0	0	0	0	0	0	0,56	14,2	3	3	3	0	0	0	0	0,86	12,9	0,7	-0,3	-1,8	1,2	
Projectplan	2	2	1	0	0	0	0	0	0	0	0,33	4	4	2	0	0	0	0	0	0,29	3,43	0,37	0,05	-0,7	0,84	
Project assignm.	--	1	0	0	0	0	0	0	0	0	0,11	0,89	--	0	0	0	0	0	0	0	0	0	0,13	0,11	-0,2	0,38
Reports	3,5	1	1	1	0	0	0	0	0	0	0,33	2	3,5	2	1	0	0	0	0	0,43	3,71	0,32	-0,1	-0,8	0,6	
Drawings	5,4	5	5	4	2	1	1	0	0	0	2	36	3	3	1	0	0	0	0	0,57	7,71	0,89	1,43	-0,5	3,34	
Minutes, etc.	3,5	4	1	1	0	0	0	0	0	0	0,67	14	2	3	3	2	2	0	0	1,43	11,7	0,68	-0,8	-2,2	0,7	
Others	--	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0,29	3,43	0,25	-0,3	-0,8	0,25		

Using  $\bar{T}_1$  and  $\bar{T}_2$  the difference in the mean time is tested.  $\bar{T}_1 = 2,26$  and  $\bar{T}_2 = 3,07$ . Consequently,  $S_1^2 \times 10 = 18,55$  and  $S_2^2 \times 6 = 2,21$ . Hence,  $S_d = 0,55$  and  $d = -0,81$ . The difference in process time is significant because  $R_1 = -1,99$  and  $R_2 = -0,37$ .

Question 12 and results

How often do you store documents in your own repository and how much time does this take?

Document types	Measurement 1								Measurement 2						t-test												
	$\bar{T}_1$	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$S_1^2 \times 8$	$\bar{T}_2$	1	2	3	4	5	6	7	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	$d$	$R_1$	$R_2$	
Policy reports	4,75	3	2	1	1	0	0	0	0	0	0,78	9,56	3	3	1	0	0	0	0	0,57	7,71	0,56	0,21	1	1,41		
Calculations	1,75	4	4	2	1	0	0	0	0	0	1,22	23,6	2	3	0	0	0	0	0	0,43	7,71	0,75	0,79	-0,8	2,41		
Formal letters	2	4	4	4	3	3	3	3	1	1	2,89	10,9	2,5	3	2	2	2	0	0	1,29	9,43	0,61	1,6	0,3	2,91	*	
Input documents	3	3	2	2	1	1	0	0	0	0	1	10	--	0	0	0	0	0	0	0	0	0	0,43	1	0,09	1,91	*
Internal orders	4,4	3	2	2	1	1	0	0	0	0	1	10	--	0	0	0	0	0	0	0	0	0	0,43	1	0,09	1,91	*
Maps	7	3	2	2	0	0	0	0	0	0	0,78	11,6	--	0	0	0	0	0	0	0	0	0	0,46	0,78	-0,2	1,76	
Memos	3	4	4	3	3	3	3	3	1	1	2,78	9,56	4,75	3	2	2	1	0	0	1,14	8,86	0,58	1,63	0,4	2,87	*	
Projectplan	4	3	3	2	2	2	1	0	0	0	1,44	12,2	3	2	1	0	0	0	0	0,43	3,71	0,54	1,02	-0,1	2,17		
Project assignm.	4,4	3	1	1	1	0	0	0	0	0	0,67	8	1	1	0	0	0	0	0	0,14	0,86	0,4	0,52	-0,3	1,38		
Reports	4,1	4	3	3	2	2	1	0	0	0	1,67	18	1	3	2	0	0	0	0	0,71	9,43	0,71	0,95	-0,6	2,47		
Drawings	5	5	4	3	2	1	0	0	0	0	1,67	30	1	2	1	0	0	0	0	0,43	3,71	0,78	1,24	-0,4	2,92		
Minutes, etc.	3,25	5	4	3	3	3	3	3	0	0	2,67	22	2,67	3	2	1	1	0	0	1	8	0,74	1,67	0,08	3,25	*	
Others	--	0	0	0	0	0	0	0	0	0	0	0	4	5	3	1	0	0	0	1,29	23,4	0,65	-1,3	-2,7	0,11		

Using  $\bar{T}_1$  and  $\bar{T}_2$  the difference in the mean time is tested.  $\bar{T}_1 = 3,88$  and  $\bar{T}_2 = 2,49$ . Consequently,  $S_1^2 \times 11 = 22,37$  and  $S_2^2 \times 9 = 14,84$ . Hence,  $S_d = 0,58$  and  $d = 1,40$ . The difference in process time is significant because  $R_1 = 0,14$  and  $R_2 = 2,65$ .

APPENDIX D. QUESTIONNAIRE HSLS CASE AND RESULTS

Question 13 and results

How often do you have doubts about a document's status or version?

Document types	Measurement 1								Measurement 2						t-test										
	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$S_1^2 \times 8$	1	2	3	4	5	6	7	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	$d$	$R_1$	$R_2$	
Policy reports	3	2	2	2	1	1	0	0	0	1,22	9,56	1	0	0	0	0	0	0	0,14	0,86	0,43	1,08	0,15	2,01	*
Calculations	2	1	0	0	0	0	0	0	0	0,33	4	0	0	0	0	0	0	0	0	0	0,27	0,33	-0,2	0,91	
Formal letters	3	2	2	1	1	1	0	0	0	1,11	8,89	1	0	0	0	0	0	0	0,14	0,86	0,42	0,97	0,07	1,87	*
Input documents	1	1	1	0	0	0	0	0	0	0,44	2,22	0	0	0	0	0	0	0	0	0	0,2	0,44	0,01	0,88	*
Internal orders	1	0	0	0	0	0	0	0	0	0,11	0,89	1	0	0	0	0	0	0	0,14	0,86	0,18	-0	-0,4	0,35	
Maps	3	2	2	2	1	1	1	0	0	1,33	8	1	1	0	0	0	0	0	0,29	1,43	0,41	1,05	0,16	1,93	*
Memos	1	1	0	0	0	0	0	0	0	0,22	1,56	1	0	0	0	0	0	0	0,14	0,86	0,21	0,08	-0,4	0,53	
Projectplan	2	2	2	2	0	0	0	0	0	0,89	8,89	2	0	0	0	0	0	0	0,29	3,43	0,47	0,6	-0,4	1,62	
Project assignm.	1	0	0	0	0	0	0	0	0	0,11	0,89	0	0	0	0	0	0	0	0	0	0,13	0,11	-0,2	0,38	
Reports	1	1	0	0	0	0	0	0	0	0,22	1,56	1	0	0	0	0	0	0	0,14	0,86	0,21	0,08	-0,4	0,53	
Drawings	5	5	3	2	1	1	1	0	0	2	30	1	1	0	0	0	0	0	0,29	1,43	0,76	1,71	0,09	3,33	*
Minutes, etc.	3	2	2	1	1	0	0	0	0	1	10	1	0	0	0	0	0	0	0,14	0,86	0,44	0,86	-0,1	1,81	
Others	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0,14	0,86	0,12	-0,1	-0,4	0,12		

Question 14 and results

How often do doubts regarding a document's status or version results in a search action?

Document types	Measurement 1								Measurement 2						t-test										
	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$S_1^2 \times 8$	1	2	3	4	5	6	7	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	$d$	$R_1$	$R_2$	
Policy reports	1	1	1	0	0	0	0	0	0	0,33	2	0	0	0	0	0	0	0	0	0	0,19	0,33	-0,1	0,74	
Calculations	1	0	0	0	0	0	0	0	0	0,11	0,89	0	0	0	0	0	0	0	0	0	0,13	0,11	-0,2	0,38	
Formal letters	3	2	1	1	1	0	0	0	0	0,89	8,89	0	0	0	0	0	0	0	0	0	0,4	0,89	0,03	1,75	*
Input documents	1	1	1	1	0	0	0	0	0	0,44	2,22	0	0	0	0	0	0	0	0	0	0,2	0,44	0,01	0,88	*
Internal orders	1	1	0	0	0	0	0	0	0	0,22	1,56	0	0	0	0	0	0	0	0	0	0,17	0,22	-0,1	0,58	
Maps	2	1	1	1	1	1	0	0	0	0,78	3,56	2	0	0	0	0	0	0	0,29	3,43	0,36	0,49	-0,3	1,26	
Memos	1	0	0	0	0	0	0	0	0	0,11	0,89	0	0	0	0	0	0	0	0	0	0,13	0,11	-0,2	0,38	
Projectplan	2	2	1	1	1	0	0	0	0	0,89	4,89	0	0	0	0	0	0	0	0	0	0,3	0,89	0,25	1,53	*
Project assignm.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Reports	1	1	1	0	0	0	0	0	0	0,33	2	0	0	0	0	0	0	0	0	0	0,19	0,33	-0,1	0,74	
Drawings	5	5	3	2	1	1	0	0	0	1,89	32,9	1	0	0	0	0	0	0	0,14	0,86	0,78	1,75	0,07	3,42	*
Minutes, etc.	2	2	1	0	0	0	0	0	0	0,56	6,22	0	0	0	0	0	0	0	0	0	0,34	0,56	-0,2	1,28	
Others	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

Question 15 and results

How often does it occur that you worked with a document which had a wrong status or version?

Document types	Measurement 1								Measurement 2						t-test										
	1	2	3	4	5	6	7	8	9	$\bar{X}_1$	$S_1^2 \times 8$	1	2	3	4	5	6	7	$\bar{X}_2$	$S_2^2 \times 6$	$S_d$	$d$	$R_1$	$R_2$	
Policy reports	1	1	1	1	0	0	0	0	0	0,44	2,22	0	0	0	0	0	0	0	0	0	0,2	0,44	0,01	0,88	*
Calculations	1	1	0	0	0	0	0	0	0	0,22	1,56	0	0	0	0	0	0	0	0	0	0,17	0,22	-0,1	0,58	
Formal letters	1	1	1	1	0	0	0	0	0	0,44	2,22	0	0	0	0	0	0	0	0	0	0,2	0,44	0,01	0,88	*
Input documents	1	1	1	0	0	0	0	0	0	0,33	2	0	0	0	0	0	0	0	0	0	0,19	0,33	-0,1	0,74	
Internal orders	1	1	1	0	0	0	0	0	0	0,33	2	0	0	0	0	0	0	0	0	0	0,19	0,33	-0,1	0,74	
Maps	2	1	1	1	1	0	0	0	0	0,78	3,56	1	0	0	0	0	0	0	0,14	0,86	0,28	0,63	0,03	1,24	*
Memos	1	1	0	0	0	0	0	0	0	0,22	1,56	0	0	0	0	0	0	0	0	0	0,17	0,22	-0,1	0,58	
Projectplan	1	1	1	1	0	0	0	0	0	0,56	2,22	0	0	0	0	0	0	0	0	0	0,2	0,56	0,12	0,99	*
Project assignm.	1	1	0	0	0	0	0	0	0	0,22	1,56	0	0	0	0	0	0	0	0	0	0,17	0,22	-0,1	0,58	
Reports	1	1	1	1	0	0	0	0	0	0,44	2,22	0	0	0	0	0	0	0	0	0	0,2	0,44	0,01	0,88	*
Drawings	2	1	1	1	1	0	0	0	0	0,78	3,56	1	0	0	0	0	0	0	0,14	0,86	0,28	0,63	0,03	1,24	*
Minutes, etc.	1	1	1	0	0	0	0	0	0	0,33	2	0	0	0	0	0	0	0	0	0	0,19	0,33	-0,1	0,74	
Others	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0,14	0,86	0,12	-0,1	-0,4	0,12		





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## Summary in Dutch

### Probleemdomein

In toenemende mate maken organisaties gebruik van elektronische documenten. Het gaat hierbij om documentaire informatie, die in elektronische vorm wordt gebruikt. Als gevolg van het gebruik van elektronische documenten, worden organisaties met een aantal problemen geconfronteerd. Dit onderzoek is gericht op de volgende problemen:

- een belangrijk deel van de elektronische documentaire informatie wordt niet beheerd;
- als gevolg van het gebruik van multimediale technieken in elektronische documenten volstaat de reguliere vorm van documentopslag en -ontsluiting niet meer;
- het ontsluiten van grote hoeveelheden elektronische documentaire informatie;
- de authenticiteit en integriteit van documentaire informatie.

Bij het zoeken naar oplossingen voor deze problemen zijn drie perspectieven ten aanzien van documenten gehanteerd: het archivalische, het organisatorische en het technologische perspectief. Het archivalische perspectief benadrukt het belang van documenten, waarbij onderscheid wordt gemaakt tussen de informatiewaarde en de juridische waarde. Het organisatorische perspectief benadrukt het belang van documenten als medium voor informatie-overdracht, nodig voor de coördinatie van bedrijfsprocessen. In het technologische perspectief staat de integratie van verschillende informatietypen centraal.

In de literatuur komen verschillende definities van het begrip 'document' voor waarbij tevens verschillende klassifikaties van documentgebruik worden gehanteerd. Op basis van een analyse van de voorkomende definities en klassifikaties zijn zes aspecten onderscheiden:

- het document als informatiedrager;
- de informatie die het document bevat;
- de presentatiemogelijkheden die het document biedt;
- de mogelijkheden om de informatie-inhoud van documenten te veranderen;
- de documentuitwisseling;
- het documentbeheer.

Er is een nauwe relatie tussen de informatie-inhoud van documenten en de wijze waarop ze worden bewerkt en uitgewisseld enerzijds, en de

bedrijfsprocessen waarin ze worden gebruikt anderzijds. Het inrichten van de documentaire informatiehuishouding vereist derhalve een analyse van de bedrijfsprocessen. Bij de analyse van bedrijfsprocessen zijn drie niveaus onderscheiden: het micro niveau, het meso niveau en het macro niveau. Op het micro niveau staan de uit te voeren taken en een effectieve technologische ondersteuning centraal. Op het meso niveau staan de processen centraal en de wijze waarop deze op elkaar kunnen worden afgestemd. Het macro niveau richt zich op de samenwerkingsverbanden tussen en boven organisaties.

Processen verschillen in de mate van voorspelbaarheid. Dit is de mate waarin voorafgaand aan de uitvoering van een proces kan worden aangegeven welke taken in welke volgorden kunnen worden uitgevoerd, en welke informatie hierbij wordt gebruikt. Minder goed voorspelbare processen vereisen een andere, meer flexibele, technische ondersteuning dan goed voorspelbare processen. Minder goed voorspelbare processen maken veel gebruikt documentaire informatie. Goed voorspelbare processen maken daarentegen veel gebruik van gestructureerde informatie.

De doelen van elektronisch documentbeheer worden vanuit de drie gehanteerde perspectieven verschillend ingevuld. Het doel van elektronisch documentbeheer vanuit archivistisch perspectief is het zorg dragen voor langdurige beschikbaarheid van elektronische documenten nodig om een organisatorisch proces te reconstrueren. Hiertoe dienen alle relevante documenten geregistreerd en gearchiveerd te worden. Vanuit organisatorische perspectief is het doel van elektronisch documentbeheer het leveren van een bijdrage aan de effectiviteit van organisaties. Vanuit technologisch perspectief is het doel van elektronisch documentbeheer de integratie van technische hulpmiddelen.

Tussen de doelen vanuit het archivistische perspectief en het organisatorische perspectief bestaat een spanning. Het organisatorische perspectief stelt, afgeleid van de effectiviteitsbijdrage, een optimale procesinrichting en ondersteuning centraal. Dit vereist een nauwe afstemming van elektronisch documentbeheer met het betreffende bedrijfsproces. Het archivistische perspectief stelt evenwel dat elektronisch documentbeheer een voorziening is die ten aanzien van alle bedrijfsprocessen volledige en actuele documentaire informatie dient te garanderen. In dit onderzoek is het archivistische perspectief als startpunt gehanteerd ten aanzien van de inrichting van het elektronisch documentbeheer. Uitgaande van het algemene karakter van elektronisch documentbeheer, gericht op de

ondersteuning van een veelheid aan bedrijfsprocessen, is de term 'electronische documentaire infrastructuur' gehanteerd.

Een electronische documentaire infrastructuur omvat technische, informatie-kundige en organisatorische voorzieningen, gericht op het ondersteunen van een veelheid aan bedrijfsprocessen aangaande het beheer van electronische documenten.

### **Onderzoeksvragen**

Doel van onderhavig onderzoek is het ontwikkelen van een methode aangaande het ontwerp van een electronische documentaire infrastructuur. Aan het onderzoek liggen de volgende onderzoeksvragen ten grondslag:

1. Welke functionaliteiten dient een electronische documentaire infrastructuur te hebben zodat een grote diversiteit aan bedrijfsprocessen kan worden ondersteund?
2. Welke bedrijfsprocessen, gekarakteriseerd op basis van de voorspelbaarheid en het documentgebruik, kunnen worden ondersteund met een electronische documentaire infrastructuur?
3. Hoe kan optimale procesondersteuning en algemene bruikbaarheid van de electronische documentaire infrastructuur met elkaar in evenwicht worden gebracht?
4. Welke bijdrage levert een electronische documentaire infrastructuur aan de doeltreffendheid, doelmatigheid en beheersbaarheid van een organisatie?

### **Onderzoeksaanpak**

De discipline informatiesystemen wordt gekenmerkt door voortdurende technische veranderingen en innovatie. Als gevolg hiervan ontstaan nieuwe problemen, die nieuwe theorieën vereisen om tot een oplossing te komen. Electronisch documentbeheer is zo'n nieuw probleem dat om een nieuwe theorie vraagt. Theorie-ontwikkeling vereist een andere onderzoeksaanpak dan theorie-toetsen. Dit onderzoek richt zich op theorie-ontwikkeling: op welke wijze dient een organisatie vorm te geven aan electronisch documentbeheer zodat genoemde problemen worden opgelost. Onderhavig onderzoek is uitgevoerd volgens de inductief-hypothetische onderzoeksaanpak omdat deze aanpak bestaande problemen als uitgangspunt neemt en door inductief redeneren naar oplossingen zoekt. Probleemspecificatie, gebaseerd op literatuuronderzoek en casus onderzoek, neemt derhalve in deze onderzoeksaanpak een belangrijke plaats in. In dit onderzoek zijn drie inductieve cases bij het Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (VROM) uitgevoerd. Op basis van literatuuronderzoek en de ervaringen uit deze cases wordt een

aanpak voorgesteld voor het ontwerpen van een elektronische documentaire infrastructuur. Deze aanpak is getoetst in een vierde casus die is uitgevoerd bij het Projectbureau Hogesnelheidslijn Zuid-Infra.

### **Casus 1: De individuele huursubsidie**

De individuele huursubsidie (IHS) heeft tot doel kwalitatieve woonvoorzieningen toegankelijk te houden voor personen met een laag inkomen. Personen voor wie de huur te hoog is in verhouding tot hun inkomen kunnen in aanmerking komen voor individuele huursubsidie. De individuele huursubsidie wordt uitgevoerd door VROM in samenwerking met gemeenten en woningbouwverenigingen.

De analyse van het IHS-proces op macro niveau laat zien dat de IHS een routinematig proces is, waarbij verschillende vormen van samenwerking voorkomen tussen gemeenten en verhuurders. Evenals het proces is ook het documentgebruik goed voorspelbaar. In hoge mate wordt gebruik gemaakt van gestructureerde informatie. De gebruikte IT-toepassingen zijn specifiek ontwikkeld voor de ondersteuning van het IHS-proces. Documentbeheer is gerelateerd aan de aanvraag. De aanvraag en de bijbehorende bescheiden worden als een eenheid geregistreerd, bewerkt en gearchiveerd.

Gegeven het volume van het proces spelen efficiëntie-overwegingen een grote rol bij het evalueren van alternatieve procesinrichtingen. Uit een ordening van alternatieve procesinrichtingen blijkt dat verbeteringen die gebaseerd zijn op een analyse van het documentgebruik suboptimaal zijn. Alternatieven op het niveau van de procesinrichting waarbij de verantwoordelijkheden van organisaties op macro niveau ter discussie worden gesteld, hebben naar verwachting de grootste efficiëntieverbetering tot gevolg. De impact van deze alternatieven op iHS-wegeving is eveneens groot.

Het volume van het IHS-proces en het gebruik van specifieke toepassing maakt duidelijk dat de IHS om een IT-ondersteuning vraagt die sterk op het proces is afgestemd. Een algemeen bruikbare vorm van ondersteuning, zoals een elektronische documentaire infrastructuur die biedt, lijkt onvoldoende op het proces afgestemd te zijn. Bij de organisatorische inrichting en de technische ondersteuning van het IHS proces, dient het proces van aanvraagafhandeling centraal te staan, en niet het documentgebruik.



## **Casus 2: De researchedienst van VROM**

De Recherche Dienst (RD) van het Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer heeft tot doel 'een kwalitatief hoogwaardige en professionele opsporingsdienst in stand te houden op de beleidsterreinen van VROM, in het belang van de bestuurlijke en strafrechtelijke handhaving van de VROM wet- en regelgeving door middel van feitenonderzoek'. De RD is regionaal georganiseerd. Als gevolg van de politieke en bestuurlijke aandacht voor fraudebestrijding heeft de RD een sterke groei doorgemaakt in de periode 1994-1996.

Het management van de RD ondervindt een aantal document gerelateerde problemen. Het management heeft onvoldoende informatie over de status van onderhanden werk. Het stellen van prioriteiten en het plannen van werk wordt hierdoor bemoeilijkt. De doorlooptijd van een relatief groot aantal onderzoeken is te lang. Van alle onderzoeken naar individuele huursubsidiefraude is 85% niet binnen de vereiste drie maanden afgerond. Vrijwel alle informatie binnen de RD is in papieren vorm aanwezig. De fysieke ruimte aanwezig voor dossieropslag is reeds voor 75% in gebruik. De RD verwacht een sterke toename in het aantal onderzoeken. Als gevolg hiervan is de opslagruimte binnen afzienbare tijd ontoereikend.

De analyse van de werkprocessen bij de RD laat zien dat het onderzoeksproces op hoofdlijnen goed te structureren is. De specifieke invulling van een onderzoek en de uit te voeren onderzoeksactiviteiten zijn echter divers. Documentregistratie en voortgangsregistratie zijn onafhankelijk van elkaar geïmplementeerd. Een rechercheur dient het initiatief te nemen om de voortgang te registreren. Documentregistratie wordt door een medewerker van het secretariaat uitgevoerd. De voortgangsregistratie en de documentregistratie is sterk afhankelijk van de discipline van medewerkers om zaken te registreren. Het blijkt dat indien er sprake is van een hoge werkdruk, het registreren een lage prioriteit krijgt. Ter ondersteuning van de documentregistratie en voortgangsregistratie wordt gebruik gemaakt van verschillende, niet geïntegreerde of gekoppelde toepassingen.

Het ontwerp voor elektronisch documentbeheer omvat technische voorzieningen en informatiekundige en organisatorische maatregelen. Technische voorzieningen betreffen de integratie van toepassingen gebruikt voor documentregistratie, voortgangsregistratie, het inrichten van een elektronisch archief, scan-faciliteiten en de integratie met toepassingen voor documentverwerking. Informatiekundige en organisatorische maatregelen hebben betrekking op het ontsluiten van elektronische documenten en het inrichten van het elektronisch archief, het toewijzen van

verantwoordelijkheden inzake document- en voortgangsregistratie, het vaststellen van de te scannen documenten en het opstellen van een lijst van te bewaren documenten.

Het ontwerp voor elektronisch documentbeheer kan alleen zinvol worden toegepast indien het merendeel van de gebruikte informatie elektronisch beschikbaar is. Vanwege de bewijskracht van papieren documenten, zal de RD ook gebruik blijven maken van papieren documenten. Het ontwerp voor elektronisch documentbeheer vereist dat procedures inzake documentbeheer worden nageleefd. Hierbij doet zich hetzelfde probleem voor als in de initiële probleemsituatie inzake het naleven van de registratieprocedures.

### **Casus 3: De Rijksplanologische Dienst**

Het doel van de Rijksplanologische Dienst (RPD) is 'het scheppen van voorwaarden voor moderne maatschappelijke en economische ontwikkelingen op een dusdanige wijze dat de kwaliteit van de moderne omgeving wordt behouden en waar mogelijk wordt verbeterd'. In deze casus zijn de documentstromen van en naar het directieteam (DT) van de RPD onderzocht. Aanleiding hiervoor waren de problemen die het DT ondervond inzake het hebben van complete dossiers, het ontbreken van informatie over vervolgacties op genomen besluiten, en het kunnen plannen van onderwerpen waarover besluitvorming is gewenst.

Uit de analyse van de probleemsituatie inzake de documenttoelevering aan het DT blijkt dat het DT behoefte heeft aan meer procesinformatie en beter toegankelijke documentaire informatie. Het ontwerp voor het elektronisch documentbeheer voor de RPD is hierop gericht. Het ontwerp is opgesteld naar analogie van het ontwerp voor de Recherche Dienst. Hieruit blijkt dat de proces dimensie binnen de RPD minder sterk aanwezig is dan binnen de Recherche Dienst. De Recherche Dienst heeft behoefte aan meer detailinformatie dan het DT.

Het beschikbaar stellen van faciliteiten voor elektronisch documentbeheer op de werkplek roept hetzelfde dilemma op dat reeds geconstateerd is bij de Recherche Dienst. Het vooraankondigen van onderwerpen bij de secretaris van het DT is nu ook mogelijk maar gebeurt niet. Indien faciliteiten voor documentbeheer op de werkplek beschikbaar worden gesteld, en deze de mogelijkheid bieden om een gewenste datum voor besluitvorming op te nemen, moet deze wel worden geregistreerd.

## **Ontwerpaanpak**

De ontwerpaanpak wordt toegelicht aan de hand van de achterliggende denkwijze, werkwijze, modelleringswijze en beheersingswijze.

Kenmerkend voor de denkwijze is dat problemen inzake documentbeheer en procesbeheersing zich niet beperken tot één specifiek proces in de organisaties, maar meerdere doelgerichte processen omvatten. Een infrastructurele oplossing is derhalve gewenst. De ontwerpaanpak is probleem gericht. Een gedegen analyse van de probleemsituatie omvattende een inventarisatie van het documentgebruik is startpunt voor de ontwerpaanpak.

De werkwijze wordt getypeerd door het parallel ontwikkelen van een globaal en een detailontwerp. Het globale ontwerp bevat de toe te passen principes van procesbeheersing. Dit principe wordt gebruikt voor het ontsluiten van documenten. Tevens bevat het globale ontwerp de technische architectuur, de toe te passen methode van versiebeheer en een beschrijving inzake de organisatorische verantwoordelijkheden voor documentbeheer. Het globale ontwerp komt in nauw overleg met het verantwoordelijk management tot stand. De detailuitwerking hiervan vindt plaats in nauw overleg met toekomstige gebruikers van de elektronische documentaire infrastructuur. Het detailontwerp wordt getoetst in de praktijk door het bouwen van een prototype dat wordt getest in een pilotproject.

Centraal in de modelleringswijze staat de vorming van een procesboom en een documentenboom. Deze modellen geven de samenhang weer tussen de processen in de organisatie en de gebruikte documenten.

Belangrijk element in de beheerswijze is het scheppen van draagvlak in de organisatie voor de invoering van de elektronische documentaire infrastructuur. Dit draagvlak is van groot belang gegeven de verschuiving in verantwoordelijkheden aangaande het documentbeheer als gevolg van de invoering van een elektronische documentaire infrastructuur.

## **Toetsing van de ontwerpaanpak: Casus Projectbureau HSL-Zuid Infra**

De ontwerpaanpak is toegepast bij het Projectbureau HSL-Zuid. Het projectbureau is verantwoordelijk voor het ontwerp en de realisatie van de hogesnelheidslijn. Hierbij ontstaan veel elektronische documenten. Het beheer van deze documenten is van groot belang voor de kwaliteit van het ontwerp. Tevens dient het projectbureau te zijner tijd een spoorlijn inclusief technische documentatie op te leveren.

Het toepassen van de ontwerpaanpak laat zien dat het onderscheid tussen globaal- en detailontwerp de mogelijkheid biedt om het overleg met belanghebbende te structureren. Het globaalontwerp is in nauw overleg met het HSL-management opgesteld, het detailontwerp in nauw overleg met een pilotteam. Tevens biedt het onderscheid tussen globaal- en detailontwerp de mogelijkheid om de projectorganisatie hierop af te stemmen.

Uitgangspunt in de ontwerpaanpak is dat de structuur voor documentontsluiting gebaseerd is op het in de organisatie gehanteerde principe van procesbeheersing. In het projectbureau bleken hiervoor twee principes in aanmerking te komen: beheersingseenheden en objectenboom. Uiteindelijke zijn beide principes in onderlinge samenhang toegepast. Het principe voor procesbeheersing is in overleg met het HSL-management vastgesteld.

Alvorens het besluit door het HSL-management was genomen om de elektronische documentaire infrastructuur op alle werkplekken in de organisatie te implementeren, is het prototype twee keer ingrijpend aangepast. Het prototype is in nauw overleg met het pilotteam ontwikkeld. Het pilotteam heeft het prototype gedurende een aantal weken getest. Voorafgaand aan het testen is een nulmeting naar het documentgebruik in het pilotteam uitgevoerd. Deze meting is herhaald nadat het team 6 weken met het prototype had gewerkt. Hieruit blijkt dat een elektronische documentaire infrastructuur met name een bijdrage levert aan de effectiviteit en de beheersbaarheid van de organisatie. Er treedt ook een efficiëntieverbetering op, zij het dat deze beperkt is.

### **Conclusies**

Om doelgericht processen op een infrastructurele wijze te ondersteunen dient de documentaire infrastructuur de volgende functies te hebben:

- integratie van documentbeheer en procesbeheersing;
- het kunnen relateren van documenten aan processen;
- integratie met alle documentbewerkende applicaties;
- functionaliteiten ten behoeve van beheer van papieren documenten;
- beschikbaarstelling op elke werkplek zodat (beperkte) documentaire taken ook door medewerkers uit het primaire proces kunnen worden uitgevoerd.

De elektronisch documentaire infrastructuur richt zich op processen die:

- een relatief groot aantal moeilijk voorspelbare activiteiten bevatten;
- uit een beperkt aantal fasen bestaan waarop kan worden gestuurd;
- veel gebruik maken van elektronisch beschikbare documentaire informatie.

De doelgerichte processen waar de elektronische documentaire infrastructuur geschikt voor is, hebben gemeenschappelijk dat zij volgens eenzelfde principe worden aangestuurd. Het vaststellen van dit principe is van groot belang bij het zoeken naar een evenwicht in de optimale ondersteuning van processen en de algemene bruikbaarheid van de infrastructuur.

De elektronische documentaire infrastructuur levert vooral een bijdrage aan de effectiviteit en beheersbaarheid van een organisatie. Er is ook sprake van een efficiëntiebijdrage, zij het dat deze gering is.

De elektronisch documentaire infrastructuur biedt de mogelijkheid om alle elektronische documentaire informatie te beheren in een organisatie. Hierdoor is het probleem van de blijvende toegankelijkheid en duurzaamheid niet opgelost. Doordat alle elektronische documenten beheerd worden, komen nieuwe wegen beschikbaar waarlangs met het probleem van de digitale duurzaamheid kan worden omgegaan. Bijvoorbeeld geautomatiseerde conversie behoort tot de mogelijkheden. Het is zinvol te onderzoeken op welke wijze met het probleem van de digitale duurzaamheid kan worden omgegaan, uitgaande van een volledig documentbeheer.

Een elektronische documentaire infrastructuur biedt ondersteuning aan, en structureert elementen in, de taakuitoefening van professionals die tot op heden vrij gelaten werden. Als gevolg hiervan neemt de vrijheid in de taakuitoefening af waardoor weerstanden kunnen ontstaan. Het is zinvol te onderzoeken op welke wijze hiermee kan worden omgegaan, zowel in termen van projectorganisaties als in termen van functionaliteiten van de infrastructuur.

Een groot deel van de functionaliteiten van de elektronische documentaire infrastructuur hebben een generiek karakter. Naar verwachting zijn deze functionaliteiten bruikbaar voor andere organisaties dan het Projectbureau HSL Zuid-Infra. Het is zinvol te onderzoeken in welke mate de elektronische documentaire infrastructuur een generiek karakter heeft, op basis waarvan vast te stellen is welke functionaliteiten op het niveau van besturings-systemen kunnen worden geïmplementeerd.



## Curriculum Vitae

Jaap J.M. Uijlenbroek was born in Pijnacker on March 9th, 1965. He studied at the Polytechnic Institute The Hague, where he graduated in 1986 from the information systems department. In 1991 he graduated from Erasmus University Rotterdam where he studied public administration. From 1986 to 1990 he worked at the Interfacultair Reactor Instituut of the Delft University of Technology as a systems developer and programmer (0.5 fte). At the same time, he was employed as a teacher and a system manager at the School for Business Administration and Economics in The Hague (0.5 fte). After his graduation from Erasmus University Rotterdam he was employed full-time for three years by ODRP, a consultancy business specialized in local authorities. In addition to his consultancy work, he remained a part-time teacher. In 1994 he started working on the research project described in this thesis at the School of Systems Engineering, Policy Analysis and Management of the Delft University of Technology. At the same time he resigned from his position as a part-time teacher, and reduced his full-time consultancy work to 0.4 fte. His research findings were presented at conferences in Hawaii, Växjö, Brussels, and Delft. He also assisted two master students in their terminal projects. Furthermore, he was involved in the development and teaching of a number of courses. Currently, he is employed as a consultant of Het Expertise Centrum, a corporation specialized in organizational and informational matters in the public sector.

