Development and Implementation of Planning Information Systems in collaborative spatial planning processes

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Preface

Since 1997, the subject of planning information systems (PIS) represents a core research theme in the institute for urban and regional planning - university of Karlsruhe (Institut für Städtebau und Landesplanung, ISL). The interest in this subject is not limited only to the academic research but it is directly related to practical planning activities in projects of different types and on different levels of spatial planning in different countries. Based on the results of these research activities and projects, this dissertation is an attempt to set a framework for the development and application of planning information systems in collaborative spatial planning. It is essential to mention that many persons have participated in the activities and projects that represented the practical part of this dissertation. I appreciate the direct and indirect contribution of all these persons.

I would like to thank Prof. Bernd Scholl the chairman of ISL, the one who encouraged me to explore this field and gave me the opportunity to experiment new concepts and ideas in different contexts, which have contributed to further development of this work. I thank him also for his support and guidance throughout this work.

My thanks also for Prof. Jakob Maurer for his advices and suggestions from the early stages of my work as well as for his feedback and constructive critique; opening for me new horizons that will help far beyond this work.

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I would like to extend my thanks to my current and previous colleagues in ISL - Torsten Beck, Susanne Dahm, Dirk Engelke and Sebestian Wilske - with whom I worked in the different case studies and projects which represented the practical application of the concept of PIS. I thank them for the discussions, feedback and suggestions, which directly contributed to the development of this work.

Last but not least, I thank my family, my wife and children for their support, patience and understanding.

Hany Elgendy

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List of abbreviations

Projects		
NBS	Sustainable Land Management in Stuttgart	Nachhaltiges Bauflächenmanagement Stuttgart
NST	North-south Trans European railway corridor	Die Nord Süd Transversale für Europe
SGMC	Sustainable Growth Management in Cairo	

Organizations		
ARPA	The Advanced Research Projects Agency	
EU	The European Union	
GCR	Greater Cairo Region	
ISL	Institute for Urban and Regional Planning, University of Karlsruhe	Institut für Städtebau und Landesplanung An der Universität Karlsruhe (TH)
KE	Kommunal Entwicklung GMBH	
W3C	The World Wide Web Consortium	

Technical		
ALB	Cadastre Information System in Stuttgart	Automatisiertes Liegenschaftsbuch
ASP	Active Server Page	
CAD	Computer Aided Design	
CSS	Cascading Style Sheet	
DHTML	Dynamic HTML	
Email	Electronic Mail	
FTP	File Transfer Protocol	
GIS	Geographical information systems	
HTML	Hyper Text Markup Language	
HTTP	Hypertext Transfer Protocol	
IRC	Internet Relay Chat	
ISAS	Soil Contamination Information System in Stuttgart	Informationssystem Altlasten Stuttgart
IT	Information Technology	
OOP	Object Oriented Programming	
PC	Personal Computer	
PIS	Planning Information Systems	
SIAS	Spatial Information & Access Service in Stuttgart	
UI	User Interface	
URL	Unified Resources Location	
WWW	The World Wide Web	

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“We live on an island surrounded by a sea of ignorance.

As our island of knowledge grows,

so does the shore of our ignorance”

John A. Wheele,

Scientist-philosopher and physician

the father of the Black Hole

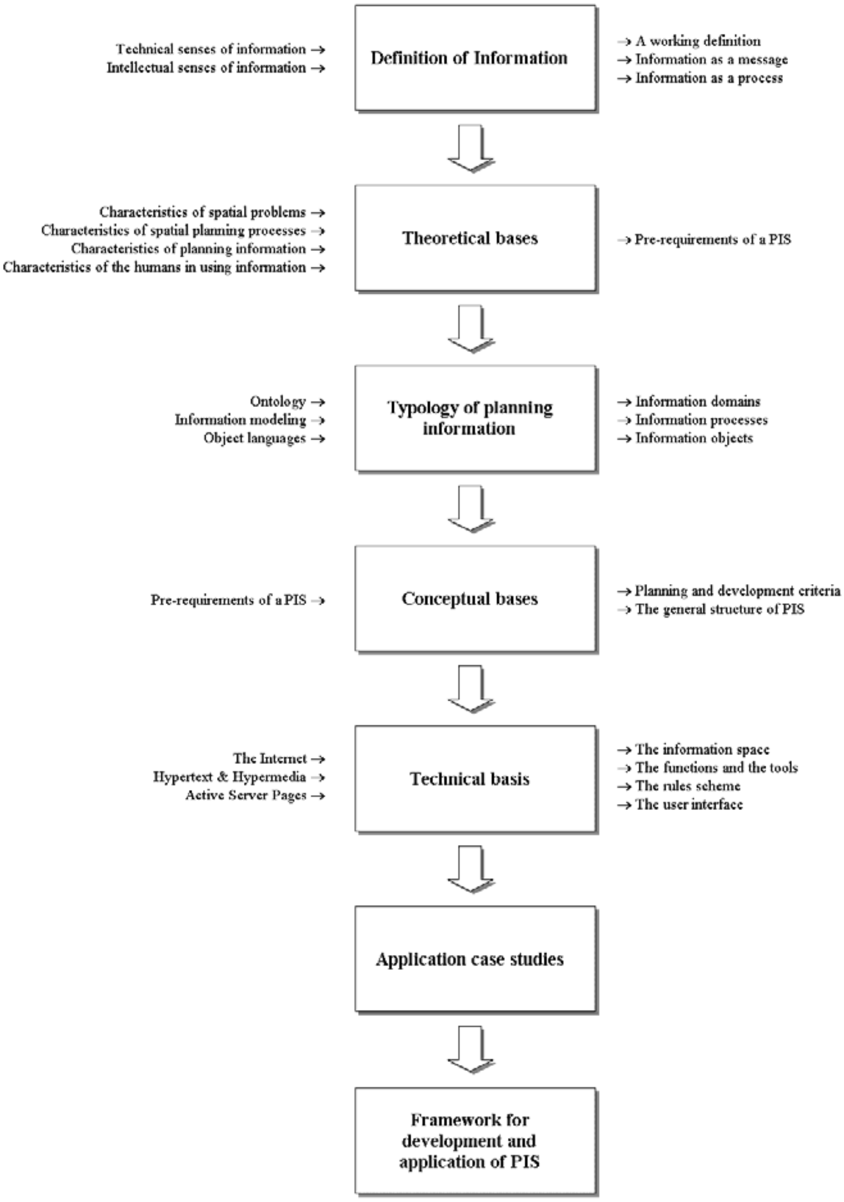
Introduction

Planning information systems (PIS) are tools for supporting the various information processes that are conducted in spatial planning processes. In developing these systems, different aspects should be considered regarding the characteristics of the spatial problems, the required processes to solve these problems and the main feature of the information that is needed, processed or produced in these processes. In addition, this information is processed and produced by humans. Hence, the characteristics of the human processing of information in general and especially in planning and decision-making should also be considered.

Furthermore, complex planning situations have specific characteristics that distinguish such a situation from a normal one. A complex situation is not a repetitive task; there are a variety of indigenous and exogenous interconnections and dynamics that influence the subject matter of planning and the results of the planned actions. In such a situation the solution options are not given or well known in advance. They should be generated. Handling complex planning tasks is usually conducted in a collaborative process among a group of individuals or organizations from different disciplines. In addition, information in these situations is characterized by being imperfect and uncertain.

Bearing in mind these characteristics of: complex planning situations, collaborative planning processes and planning information on one hand, and on the other hand witnessing the fast evolving world of information and communication technology, which introduces new innovations and opens new opportunities, it is the planners task to think about the requirements of the different tasks in spatial planning, then to explore the potentials of the new technology and to develop tools that meet the requirements of such situations. However, it is not enough to utilize the new technology by dressing up traditional concepts of the use of information with a new technology facade (Bracken 1990). The new technology encourages exploring new forms of communication and new conceptual frameworks, which consequently leads to a more effective use of information.

Thus, it is argued in this research that the development and the implementation of PIS are not merely a technical issue that could be handled by information experts. The above-mentioned factors should be considered in the development and the implementation of these systems. The intention of this dissertation is to define the main aspects that influence spatial planning in complex planning situations, then to identify the requirements of a PIS as an instrument for supporting information processing in collaborative planning processes, subsequently to explore the opportunities of applying new information and communication technologies to realize this system. Aiming at setting a framework for the development and the implementation of PIS in collaborative planning processes that deal with complex planning situations from the theoretical, conceptual, technical and operative perspectives the research has the following structure.



In chapter 1, the research starts be exploring the perception of information from different technical and intellectual viewpoints. Then the working definition of information as it is used in this research is discussed. Afterwards, the main characteristics of the human use of information are reviewed.

In chapter 2, it is argued that the role and the use of information in the various planning theories are different. Hence, the theoretical bases of PIS should be based on the main aspects that govern spatial planning, namely the characteristics of humans in processing information, the characteristics of planning problems, characteristics of planning process and last but not least characteristics of planning information. Theses characteristics are crucial for the development and the implementation of PIS.

Facing the variety of information types and the activities that are considered as information process in spatial planning, chapter 3 includes an attempt to set a typology for planning information. This typology observe planning information from different perspectives. Three main perspectives are considered important for the PIS, namely information domains, information processes and information objects. For the development of a PIS it is essential to define which domains are needed for the current case, which processes should be supported and which information objects should be included.

Chapter 4 starts by exploring the term "system" aiming at defining the main components of any system. Then, based on the characteristics that resulted from chapter 2 and the typology that resulted from chapter 3, the main conceptual criteria that should be considered in PIS are defined regarding the system structure, the system organization and the information organization. Afterwards, the general structure of PIS is introduced in the form of the main components of the proposed system.

As mentioned earlier, the search for suitable information systems for collaborative planning processes in complex situations should be based on the requirements of these situations. Hence, based on the pre-requirements and the conceptual criteria from the earlier chapters, chapter 5 is an exploration of the innovative information and communication technology, to define which techniques could be used to fulfil the task and to consider the pre-requirements of PIS. Although, the spectrum of innovative technologies is unlimited, the adopted techniques in PIS should be simple and should require no special resources. Hence, this chapter includes a set of technical criteria that should be considered.

This research is based on different experiments in a variety of projects and planning processes with special emphasis on two main areas of spatial planning. The first is the sustainable growth management in rapidly growing cities with special emphasis on inner development. The second subject is the relation between infrastructure development and spatial development. These cases are introduced in chapter 6. They cover a variety of collaborative planning processes including cross-border, cross-organization and cooperative work in ad-hoc organizations. In each of these cases, a PIS was developed and implemented. Each of these cases represents the application of PIS on a different planning level. Based on the results of these experiments, the proposed theoretical, conceptual, technical and operative framework is concluded in chapter 7.

1. Information: An exploratory review

Planning information systems are mainly aiming at supporting the organization, processing and communication of different types of information in planning processes. Setting a framework for the development and implementation of such systems requires a clear understanding of the variety and nature of information that are used, processed or produced in different types of planning processes.

Although the term "Information", nowadays, is one of the most frequently used expressions in daily life as well as in scientific writings from a wide range of disciplines, nevertheless, it is not possible to find a consensus about a common perception that is universally accepted about this term. Different perceptions of the term "information" are found in various disciplines ranging from computer science and communication on one hand, and cognitive psychology and logic on the other hand. Some of these disciplines have developed a domain-specific definition that serves principally the sole aim of this discipline. For example, telecommunication has an extremely technical view of information while philosophy has a very abstract one.

Since "information" plays an important role in the research on Planning Information Systems (PIS), it is therefore essential to clarify this ambiguity as long as it is related to the purpose of this study. Based on this clarification, it would be possible to articulate a working definition. This working definition is important since it determines "what will be regarded as information?" This will consequently preside over what will be considered as planning information. Hence, this chapter starts by a representation of different perceptions of information in some of the related disciplines to the subject of PIS, e.g. information theory, computer science, semantics and philosophy. As information is produced, processed and used by humans, it is very important in this chapter to explore different aspects of the human capacity in processing information.

1.1. Technical senses of "information"

One of the fundamental theories that dealt with information is "Information Theory". Information theory is a mathematical theory concerned mainly with the transmission, storage, and retrieval of data. In this theory, information is interpreted as: "… the messages occurring in any of the standard communications media, such as telegraphy, radio, or television, and the signals involved in electronic computers, and other data-processing devices." (Encyclopedia Britannica). Information theory utilizes a number of variables to describe information and the related processes such as transmission and storage. Among these variables are bandwidth, noise, data transfer rate, storage capacity, number of channels, accuracy, precision, and reliability. Information theory is also applied to the signals appearing in the nervous networks of human beings and animals. Since information theory is concerned predominantly with the transmission of information in the form of signals or messages, therefore it is not necessary that the transmitted message has a meaning in any ordinary sense. This anomaly is explained since it is as difficult to transmit a series of nonsense syllables exactly as it is to transmit the most valuable piece of plain text. Hence, this theory originated its interpretation of information as any message occurring in any communication media regardless of the content or the meaning of the message. It could be concluded that, information theory concentrates on quantitative problems of data transmission regardless of the content, the meaning or the type of the transmitted message.

From computer science viewpoint, information is defined as: "… stimuli that has meaning in some context for its receiver." (Whatis.com 2000). This definition goes a step further than the former by suggesting that the information should have a meaning in some context. However, for computer science information is the raw materials of a process, in which information is converted into data that could be manipulated and processed by computers. Computer science suggests that almost all kinds of information can be converted into data and passed on to another receiver. Relative to the computer, information is transformed into data, and then put into the computer where it is stored and processed as data, and then put out as data in some form that can be perceived as information.

Other technical definitions of information, as found in different technical dictionaries and writings, tend to interpret information as the organization of data as part of data processing operations. In the extremely technical definitions, information is considered as a general term for any manipulated data where meaning is apparent. In this sense, data manipulation could be conducted through any of the following processes: recording, organization, assembly, classification, relation, analysis, summary or interpretation. An example of this definition is found in GIS Dictionary (2000), which defines information as "Intelligence resulting from the assembly, analysis or summary of data into a meaningful form“. Such definitions emphasize that information is the result of data manipulation. It also stress that the result of data manipulation should be into a format that readily leads itself to hypothesis testing, planning, and decision making (Water Words Dictionary 2000).

1.2. Intellectual senses of Information

Contrary to the afore-mentioned technical definitions, semantic interpretations of information tend to include an intellectual sense that links information with its meaning. Some of these definitions consider information as corresponding to knowledge. One of these intellectual interpretations links information to the meaning resulting from a representation of a fact or a message for the receiver (Hornung: in Web Dictionary of Cybernetics and Systems). It is important to notice that another dimension is added to the earlier characteristics of information, which is that the meaning of information is not absolute in itself, but relative to the receiver. This aspect adds a new dimension to the definition of information that goes beyond the technical definition of information. The meaning of information is not standalone. It takes place only when a recipient receives the information and a meaning occur in his mind. In other words, information is not only a message but it is connected to an act that converts this message into a meaning in the receiver’s mind. For example, a bar chart, which is manipulated data, would be technically interpreted as information. However, in this intellectual sense, it is not considered information until any receiver acquires some meaning out of it.

Merriam-Webster Dictionary (2000) went a step further by defining information as the knowledge obtained from investigation, study, or instruction. This definition has a major aspect that states that information is not only obtained through data manipulation but also through other informative acts that create knowledge without data manipulation such as investigation and study. It also includes expressing ideas, suggestion, preferences and decisions. In the same direction, Wordsmyth Educational Dictionary –Thesaurus (2000) generalized the concept of the informative act as the source of knowledge, and defines information as “knowledge derived from any source”. Two major aspects of information could be identified from this semantic version of the definition of information. Firstly, the meaning of information is not absolute but relative to the receiver. Secondly, information is not only data manipulation, but it could also be acquired through informative acts. The concept of the informative acts plays an important role in the conceptualization of planning information systems. Based on this concept, the role of information systems should not be limited to organization and processing of data. It should be extended to promoting informative acts to creating opportunities to communicate, share and use available information.

From a philosophical point of view, information is regarded mostly as what reduces the uncertainty of the receiver. An example of this direction is Claude Shannon who interprets information as “that which reduces uncertainty” (Shannon, in Principia Cybernetica Web) or the more detailed definition “a message received and understood that reduces the recipient’s uncertainty” (Open Resource Online

Dictionary, 2000). Uncertainty here is defined as “The (average) number of decisions a decision maker has to make in order to select one out of a set of mutually exclusive alternatives“ (Krippendorf: in Web Dictionary of Cybernetics and Systems). However, in many situations new messages or information might increase the uncertainty of the receiver rather than to decrease it. Attempting to overcome this anomaly, the following definition goes beyond the argument of decreasing uncertainty, to be generally, what changes somebody’s knowledge, regardless of whether this change increases or decreases the knowledge. In this context, Bateson defines information as “that which changes us” (Web Dictionary of Cybernetics and Systems).

Beyond this interpretation of information as a message, Rittel (1982) stresses a different dimension of information which implies that information is not only a message, but also it is a process as well. He states, "Information is a process which leads to changing somebody's knowledge". He argues that an information process takes place when an individual, who knows something at a specific point in time "t_i", no longer knows this or know something more at the time "$t_i + \Delta t$". This definition ensures that information is a process and it occurs when a change of knowledge occurs. Both the concept of information as a process and the afore-mentioned concept of informative acts represent corner stones for the development of PIS. They shift the system from being tools for accumulating and structuring data to platforms for sharing and communicating available information.

1.3. Data, information and knowledge

The above-introduced review of the term “information” from different perspectives shows that this term is used in a larger context of several interconnected terms such as “facts”, “data” and “knowledge”. Data is the original observation of an event, a characteristic, phenomenon measurement or record of facts in a specific moment of time under specific circumstances. Raw data is recognized upon its acquisition from one of many different sources in one of many different ways through events in the real world and the world of the mind (Penzias 1989). It is important here to emphasize that data in this perspective is not limited only to the observations of the physical world, but it also results from mental events. In the conventional definition, for data to be useful and to produce information it should be selected, filtered, arranged and processed according to some principle or goal which give it some form and coherence. However, information is not only produced by data manipulation. Ideas, positions and decisions are considered information but they are not produced by the sole manipulation of data.

Information is converted into knowledge through scientific processes of generalization and the investigation of cause and effect by imposing and testing a structure, which is usually not inherited in the original data or the processed information (Penzias 1989). Knowledge is the principle or the goal obtained through the information. Here, we move from the concrete levels to the abstract levels into which details fold. This is the process through which perception becomes cognition, and through which events are organized into larger structures (Wong & Storkerson 1997). Knowledge may be converted into intelligence whenever it is applied to new ideas, suppositions, and information in an organized effort to interpret new information or to take a purposeful view of the future (Penzias 1989). In this hierarchy, when it comes to intelligence, the contact will be mainly with abstract concepts rather than with concrete facts. Thus, we have two poles: concrete and abstract. Between these two poles, we navigate up by concept formation and back by verification.

The relationship between these concepts is traditionally represented as a five-steps pyramid where facts are the base and intelligence is the top. Data, information and knowledge are the steps in-between. However, data is not only based on facts and information is not only based on data. For example, an idea or a proposal for solving some problem are not manipulations of data, but they are decisive pieces of information for solving problems. Similarly, the position of a political party against or for a specific course of development represents an important piece of information but it is not a result of data manipulation.

It is argued that our society is a data-rich but information-poor society (Shubik 1980). What is needed is not more data collection but how to select relevant data from the available ones and then to transform these data to information and then to knowledge and intelligence. It is not enough to supply data to get information or to supply information to extract knowledge. Beyond selection and transformation of data to information, it is essential to emphasize the creation of opportunities for informative acts rather than to concentrate on data collection. This differentiation among these concepts and terms is extremely important during the development and implementation of PIS.

It is important here to stress that although data is usually considered as an ingredient of information, not all data make useful information (Yeung 1998). Data that is not properly collected and organized is a burden rather than an asset to an information user. Additionally, data that makes useful information to one person may not be useful to another. Furthermore, information and knowledge have no value in themselves but their value can be realized only when it is disseminated, shared and used (Srinivas 2002). This aspect represents a basic task for PIS that is to support the creation of these opportunities for informative acts to take place.

1.4. A working definition for information

It is far beyond the scope of this research to search for an interdisciplinary definition of information. However, it is crucial for further work in this study to reach at least a working definition that considers the nature of planning processes and planning problems. In the working definition that is adopted in this study, information as a term implies in two folds. The first fold emphasizes information as a message, from any source, that changes the recipient's knowledge and/or uncertainty. The second fold introduces information as a process in which the message is encoded, communicated, decoded, interpreted and understood. Based on this understanding the change in the recipient's knowledge or uncertainty takes place. These two folds are interconnected. They represent a corner stone for the concept of PIS. As mentioned earlier information has no value in itself it gets value only when it is used or communicated.

Regarding information as a message, the following aspects are important for further discussion:

- Information is a coded message using some sort of language. Language includes, but is not limited to, coding languages (i.e. Morris language of signs), sign languages, spoken and written languages, graphics, photos, etc.
- For the recipient to decode the received information and understand the message, he should be able to understand the language in which the information is encoded.
- The meaning of the message results from the meaning of the applied symbols, the context of these symbols and the background of those who process the message. (Maurer 1988)
- The source of the message could be anything. The recipients could be also anything. This includes unattended senders and untargeted recipients.

The second fold of the information in this definition emphasizes the process of communicating this message, which emphasizes the following characteristics:

- The message should make some change either to the recipient's knowledge or to his uncertainty or to both of them, regardless of whether this change is positive or negative. Here, knowledge and uncertainty are stated separately since the received information may decrease or increase either one or both of them. This change could be in the same direction or in opposite directions.
- A message that has some meaning for the sender in some sense of communication languages but has no meaning for the recipients is not considered information in the sense discussed above. Furthermore, a message that is not received by any receptionist will not be considered information, as it will not affect anybody’s knowledge or uncertainty.
- A message that is already known to the recipients is not considered information, as it changes neither their knowledge nor their uncertainty.

1.5. Some characteristics of human information processing

The right to seek and to receive information without restrictions and regardless of the fortune is one of the basic human rights included in the Human Rights Declaration (1948). In article 19 of the declaration it is affirmed that “Everyone has the right to freedom of opinion and expression; this right includes freedom to hold opinions without interference and to seek, receive and impart information and ideas through any media and regardless of frontiers.” Since then information is considered a grantor of individual rights (Jumel 2001).

Witnessing the information revolution, seeking for information became more than a right, it is considered by many people as a need in both work and in daily life. In a study titled "*Dying for information?*" conducted by Reuters in 1996, aiming at exploring the use of information in the information age, they asked 1300 mangers from different countries different questions about their use of information. One of these questions was about the need for information. Two-thirds of managers responding expressed their need to "very high levels" of information. This tendency reflects a feeling that large amounts of information are essential to back up decisions. Nearly half of them reported that they needed to collect information to keep up with colleagues. (Reuters 1996) This result shows that information is becoming increasingly an essential need and a substantial part of the working life for many people.

As many information resources are becoming available in low cost and effort, there is a tendency to collect more information. Information is an essential ingredient in most of what we do. We spend much time gathering, refining, and interpreting information (Rouse 1992). In doing this, it is claimed that more information means better decisions. It was proved empirically that the short-term capacity of human mind in processing information is very limited. This represents a key issue for the development and implementation of PIS as it deals with the psychological characteristics of the human information processing system, which should be considered in developing these systems.

Human capacity in processing information (7 ± 2)

Human information processing system could be described in the following three steps (Hussy 1998):

- Using the different senses, human beings receive information from the surrounding environment.
- Then, using memory structures, either they save or process this information.
- At the end, they give the output again to the surrounding environment; transform it into a command to the organs or save it for later use.

Using the concept of the channel capacity on the human information processing system, the channel capacity of the human mind could be defined as the upper limit or the extent to which the observer can match his responses to the stimuli he gets (Heylighen 1991). Cognitive psychology has proved that the human mind has a very limited ability to hold more than five to nine bits of information in short term memory. Miller (1956) argues in his work "*The Magical Number Seven, Plus or Minus Two*" that the capacity of the human mind regarding the span of absolute judgment and the span of immediate memory imposes severe limitations on the amount of information that it is able to receiving, processing and remembering. Based on several experiments by different researches, he concluded that this capacity is somewhere in the neighborhood of seven. This capacity is measured as chunks of information, called bits that could be received and processed simultaneously.

However, adding several dimensions to each chunk or a sequence of chunks could stretch the information capacity bottleneck. This process is called "recoding" and is discussed in a later chapter. Consequently, it is argued that the capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required in the real world (Behn & Vaupel 1982).

During the process of developing and implementing PIS, it should be kept in mind that the capacity of the human mind in simultaneous processing of different chunks of information is severely limited. Therefore, it is also important during this process to think of ways for recoding and structuring of information that utilize this limited capacity efficiently.

Information overload

If the supplied information exceeds the channel capacity of the observer mind, information overload occurs. "Too much information can be the source of disinformation." (Jumel 2001). Information overload could occur in both folds of information, as a message and as a process. As a message, information overload could also occur from the ambiguity of the information content, if the user cannot understand the received message or is not sure about the accuracy of this piece of information. This results from the increasing diversity of information sources, forms, and languages, which makes it difficult to identify and interpret all relevant information (Rouse 1992). On the process-side, information overload could result if the observer:

- doesn't know if the information exists,
- doesn't know where to find the information,
- can't access the information (Srinivas 2002), or
- can access the information but the size of the information makes it difficult to consume the relevant information. (Rouse 1992)

In the afore-mentioned Reuters' study (1996), half of the respondents stated that they often or frequently could not cope with the volume of information they receive, resulting in a form of indigestion and sometimes the so called "*information poisoning*" (Rouse 1992). It is also evident from this study that information overload has substantial effects on both business and individual levels. On the individual level, two thirds of respondents associated information overload with tension and dissatisfaction. More than 40% connected this stress with ill health. Heylighen (1999) argues that this stress leads to psychological, physical and social problems. The psychologist David Lewis, who analyzed the findings of this survey, called the resulting symptoms of information overload "*Information Fatigue Syndrome*". He mentioned that the side effects of information overload also include anxiety, poor decision-making, difficulties in memorizing and remembering, and reduced attention span (Heylighen 1999).

On business level, the study showed extreme findings. About 40% of respondents said that they spent considerable amounts of time just looking for information. Nearly half of respondents stated that information collection distracts them from their main responsibilities. About 40% of respondents thought that decisions were either delayed or adversely affected by "*analysis paralysis*" or by the existence of too much information. (Reuters 1996)

Information overload could be minimized in PIS by considering the use of reasonable sized chunks of information and to avoiding the use of large chunks. It could be minimized by structuring and organizing the available information and knowledge in ways that reduce ambiguity and facilitate the overview so that a user can find out with minimum effort if a specific piece of information is available and how to obtain it.

The human use of information is selective

It is proved that humans use the information in a selective manner. This selective behavior is governed with both conscious and unconscious factors such as (Schönwandt 1986):

- if the information is supporting or is not conflicting with the person's opinion.
- if the information is unwished or unexpected differently.
- how easy is it to recall the information from the memory.
- how clear is the information representation.

1.6. Conclusion

This chapter is aimed at setting the working definition of the term "information" and exploring the main characteristics of the human information processing. These two aspects are crucial for the development of PIS.

In the working definition that is adopted in this research, information is understood in two folds. The first fold emphasizes information as a message from any source that changes the recipient's knowledge and/or uncertainty. The second fold implies the process of information in which the message is encoded, communicated, decoded, interpreted and understood. For the development of PIS, the two folds of information should be considered. PIS should go beyond processing information in the conventional conception as messages to consider creating informative activities.

During the process of developing and implementing PIS, it should be kept in mind that the capacity of the human mind in simultaneous processing of different chunks of information is severely limited. Therefore, it is also important during this process to think of ways for recoding and structuring of information that utilizes this limited capacity efficiently and avoid information overload.

2. Theoretical Bases of PIS

It is argued in this research that the theoretical bases of PIS should not be overwhelmed by a single approach or theory. It is also argued that the adopted planning approach or the theoretical bases that form the outline of a planning process influence directly and indirectly the use and the role of information in this process. Consequently, different planning approaches have different perceptions of the role and the use of information. To overcome these different views and to set the theoretical bases for the development and implementation of PIS, this chapter attempts to figure out the main aspects that should be considered in the design, development and implementation of PIS instead of looking for *the theory* or *the approach* of planning that should be considered the base for PIS. These aspects are related to the characteristics of spatial problems, planning processes and planning information. The conceptual bases of PIS should consider these characteristics in addition to the afore-mentioned characteristics of the human processing of information.

To achieve the afore-mentioned objective this chapter consists of two main parts. In the first part, the term "planning" is explored, both in general and "spatial planning" as a sub-class of planning. Then the use of information in different approaches of spatial planning is exemplary explored to illustrate the above-mentioned relation between the theoretical bases of an approach and the use of information in planning process that are based on this approach. The second part concentrates mainly on exploring the main characteristics of spatial problems, spatial planning processes and those of planning information. These three aspects are argued to be essential for the development and implementation of PIS.

2.1. An introduction to spatial planning

The term 'planning' is often used and seems to be simple and straightforward, not only for planners but also for everybody. However, this is not the case. 'Planning' is interpreted and used differently in various disciplines. Hall (1992) stated that "Planners of all kinds think that they know what it means: it refers to the work they do." This could have been the end of the discussion, '*planning is what planners do'*, but then, he added "The difficulty is that they do all sorts of things, and so they mean different things by the word; planning seems to be all things to all men."

This section is a short discussion of the term "planning" in general. This discussion will serve as a base for approaching to the definition of "spatial planning". In attempting to look into the meaning of "spatial planning" using different definitions, it is argued here that each definition has a vision or theory that presents its foundation.

As a general activity, the verb "*to plan*" is semantically interpreted in the following senses:

- *"To aim or to intend something"*, i.e. to have a specific aim or purpose,
- "*To design something*", i.e. to arrange the parts of, or
- "*To produce a blueprint of something*", i.e. to draw or to make a graphic representation of something (Dictionary.com).

Although these senses of the verb are frequently used, the common sense of the verb "to plan" is interpreted as "*to formulate or project the achievement of a goal*". This definition could be found in different variations such as "to formulate a scheme or program for the accomplishment of something" (Dictionary.com); "to devise or to project the realization or achievement of something" (Merriam Webster's Collegiate Dictionary); "to think about and decide on a method for doing or achieving something" (Cambridge Dictionary of American English). In this sense, "to plan" is interpreted as a human conscious action to formulate, to devise, to project, to think or to decide to define a course of action, a scheme, a program or a method to achieve some goals or to accomplish something in the future.

Maurer (1973) argues that planning of any type is based on the assumption that the future events could be influenced by intentional human actions to achieve a wished result. This assumption is based on a primary assumption that humans are capable to use their freedom wisely to decide about future actions.

It could be concluded that planning as a general activity has the following basic characteristics:

- "To plan" is a conscious activity. *Planning is not per se*.
- "To plan" is to presume about the future. *Planning is future-oriented*.
- "To plan" means having a goal or an objective. There is no planning for the sake of planning. *Planning is goal-oriented*.

- "To plan" implies assembling actions into some orderly sequence (Hall 1992). *Planning is action-oriented*.
- "To plan" is an attempt to trigger something to happen that normally would not happen without the planning; to hinder something from happening that would happen without the planning; or to change how something will happen. "To plan" is attempting to change "What is or what will be" to "What ought to be". *Planning is proactive*.

As spatial planning is considered a sub-class of planning as a general activity, it should inherit the above-mentioned basic characteristics of planning with a main distinction that it is "spatial". Semantically, the word 'spatial' is originated from the Latin word '*spatium*'. That is translated as: space, distance, room or extent - unexpectedly, it also means time and time interval! (babylon.com). The English word 'spatial' is interpreted as "relating to, occupying, or having the character of space" (Merriam Webster's Collegiate Dictionary). Hence, spatial planning should be, simply, that type of planning related to space, about occupying space, or having the character of space. If we combined this sense of the adjective "spatial" to the afore-mentioned four senses of "planning" as a general activity, spatial planning is semantically interpreted as any combination of a phrase from each column in the following diagram (Fig. 2.1).

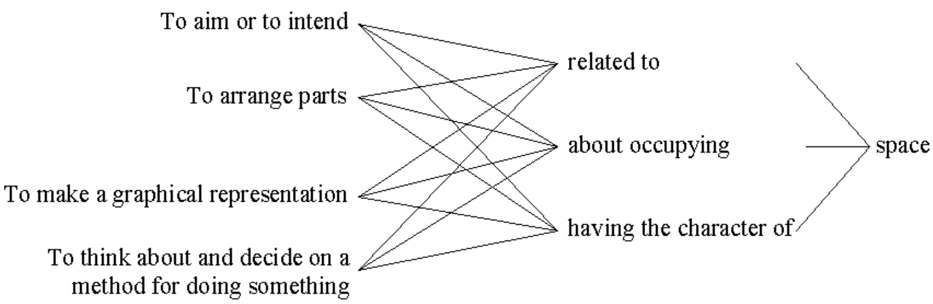


Fig. 2-1 Different semantic senses of spatial planning

Although not all these semantic definitions are regarded as forms of spatial planning from the viewpoint adopted in this research, almost each of the resulting combinations could be found, more or less, in various spatial planning literatures (e.g. Keeble 1969, Faludi 1973, Bracken 1981, Maurer 1985, Friedmann 1987, Hall 1992, Naess 1999, etc.). A huge number of definitions of spatial planning could be found in literature regarding the fact that application of spatial planning has evolved by time and it is implemented differently in different regions, countries, and levels of planning. There is also unlimited number of expressions that represent some sort of spatial planning, such as town planning, city planning, urban planning, physical planning, regional planning, national planning, comprehensive planning, master planning, etc.

In this research, spatial planning is understood as a process of formulating decisions about future actions for resolving spatial problem or conflict. This process takes place in a network of multidisciplinary actors under changing circumstances. A problem is interpreted as an obstacle. In the case of planning, a problem could be interpreted, as an obstacle between what is the case and what the case ought to be. A conflict is interpreted as mental struggle resulting from incompatible or opposing needs, drives, wishes, or external or internal demands (Merriam-Webster Dictionary 2000) The task of spatial planning is to propose solutions to overcome the gap between the “is-state” and the “ought to be state” taking in consideration the different interests or in many cases the conflicting interests. During the exploration of the role and the use of information in different approaches of spatial planning in the following section, the perception of spatial planning in these approaches will be discussed.

2.2. Information in different approaches to spatial planning

Although a thorough discussion of planning theory is beyond the scope of this research, the role and the use of information in planning processes is usually governed by the theoretical bases upon which such, a process is based. There is no spatial planning theory that is globally or permanently accepted. Different planning approaches are discussed in literature, used in different countries and implemented on different planning levels. As this section is mainly aimed at demonstrating the relation between the use of information in a specific planning approach and the theoretical bases of this approach, four approaches to spatial planning are reviewed, namely the classic approach “the blue print view of planning”, the systematic approach, the systems approach “the cybernetic approach” and “planning as a process of problem-solving”. Although a large number of approaches could be argued to be important for this review, this selection is only exemplary and is not aimed at making a comprehensive review of the relation between the use of information in different planning approaches and the theoretical bases of each approach. In addition, these approaches are considered largely to be different regarding the theoretical bases for each one. Each of these approaches embodies a different perception of the real world and consequently a different perception of the role of planning in steering the development in a specific area. This perception or view, furthermore, leads to different perceptions regarding the role of the planner, the organization of the planning process and the use of information in this process.

This section includes a brief introduction to main theoretical principles that differentiate each of these approaches. After that the role of information in each of these approaches will be explored regarding the form, processes and activities in which information is information used in this approach. These aspects are based on a set of primary questions such as: How the planning process is organized in each of these approaches? Is this process a plan-producing task or is it a continuous process? Is it a one shot event, a periodical event or a continuous process? These aspects influence also the application of information systems in each of these approaches. After this review, in the following section, these aspects will be also discussed from the viewpoint adopted in this research. These questions are:

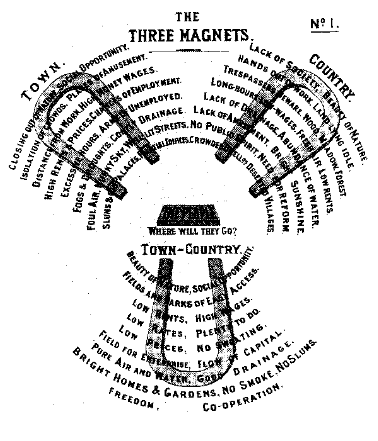
- How is the planning process organized?
- Chronologically, is the planning process continuous, one-time, or periodical?
- How is information used in this approach?
- What is the position of the plan in the planning process?
- How these aspects affect the use of information systems?

It is important here to ensure again that the following discussion of diverse approaches to spatial planning is mainly aimed at illustrating the relation between the role and use of information in a planning process on one hand, and the adopted theory or approach in this process on the other. This discussion is directly related to the basic question behind this chapter that implies: if the use of information in planning processes differ according to the adopted theory or approach, what are the main issues that should be considered in the development and implementation of PIS that are valid beyond these different theories.

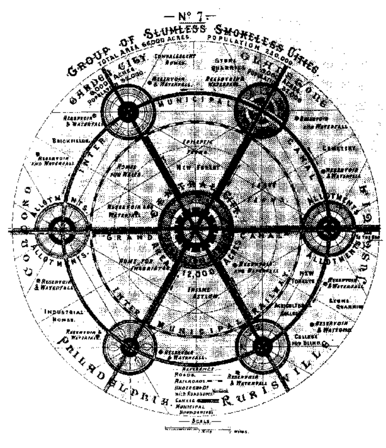
2.2.1. The classical approach "the blueprint view of planning"

The classical approach to spatial planning emerged from architecture. It was concerned with the ordering of land uses and buildings in towns aesthetically whilst considering public health. Keeble (1969) defined town planning as "The art and science of ordering the use of land and the character and sitting of buildings and communication routes so as to secure the maximum practicable degree of economy, convenience and beauty".

The planner in this approach is an individual (or a group of individuals) who has a *vision of the f*uture for a specific area. He attempts to apply his societal judgment to make a better future of an area regardless of the extent of this area or the society related to this area. This classical/traditional approach to planning, as in architecture, rested upon the belief in the ability of a human designer to produce a solution to a problem (Bracken 1981).



Ebenezer Howard's Garden City 1898



Howard's Social City – the full concept of the garden city

Fig. 2-2 An example of the classical approach to planning (Hall 1992)

The planning process in the classical approach could be described as a process where the planner visualizes the future of an area by attempting to manipulate the physical environment, while assuming that the society behavior will adopt or will be controlled by this manipulation. In doing this, at least the planner or the designer has the confidence that the proposed solution may work, although he cannot say specifically how the solution was obtained or why it may work.

This type of planning could be classified under the “black-box” approach to problem solving. By definition, in black-box processes the input and the output of the process are visible while the throughput is not visible. However, in this approach only the output of the design or the planning process, namely the plan, is visible while the whole process is hidden. The planning process, i.e. the plan production, is a one-time event. When the plan is produced, the planning is over.

From an organizational viewpoint, this process is centrally organized. An individual or a group of individuals supported by others, just to assist him/them to achieve his/their goal, which is to produce the plan. The major objective of this type of planning is producing plans that give a detailed picture of a desired future. Hall (1992) described this approach as the production of blueprints for the future desired state of an area. The centerpiece of the planning is the plan. In other words, the plan is the planning and the planning is the plan. It could be then argued that this approach is plan-based.

The main information process in the classical approach is the plan communication. The planner transfers his image of the future - the solution or the plan - to others who should carry it out. The plan is then the main piece of information. Consequentially, the use of information systems in this approach is mainly oriented to the plan production and visualization. Here the planner, supported normally by others, produces his/their vision of the future in the form of plans. The main computer applications that might be used are CAD programs and visualization programs.

2.2.2. The systematic view of planning

The systematic approach was an attempt to move away from the black-box classical approach that was based, to a great extent, on the intuition and the private judgment of the designer or the planner. It was evident that the problems in the urban context have become far more complex to be a matter of private judgment for even the most experienced designer or planner (Jones 1970). This shift from the black box to a more systematic and externalized process was initiated by the high cost of error and the difficulty to correct it, especially in complex urban contexts. By using the systematic process it is assumed that the planner’s ideas would be subject to criticism and discussion before expensive mistakes are made (i.e. glass-box vs. black-box in the classical approach).

One of the thinkers of this approach is the Scot planner Sir Patrick Geddes (1854-1932) who has been called the father of modern town planning. Geddes has formulated the systematic approach to urban planning, in a compact notation known as *'survey - analysis - plan'*. The systematic approach implies the following: Survey the existing situation; analyze the survey to find out the remedial actions that need to be taken; fix a plan that embodies these actions. Different detailed or enhanced versions of this concept were introduced and used by making the planning process iterative and inclusion feedback-loops or sub-processes. Nevertheless, the core of the process is more or less the three-phase-process systematic approach. A detailed and enhanced version of the systematic approach to spatial planning, that was adopted in many countries for a long time and till now, takes the following form (Fig. 2.3):

> "First the planner made a survey, in which s/he collected all the relevant information about the development of their city or region. Then s/he analyzed these data, seeking to project them as far as possible into the future to discover how the area was changing and developing. And thirdly, s/he planned: that is. S/he made a plan which took into account the facts and interpretations revealed in the survey and analysis, and which sought to harness and control the trends according to principles of sound planning. The period between plans should be defined. For example, every five years the process should be repeated: the survey should be carried out again to check for facts and developments, the analysis should be reworked to see how far the projections needed modifying, and the plan should be updated accordingly." (Hall 1992)

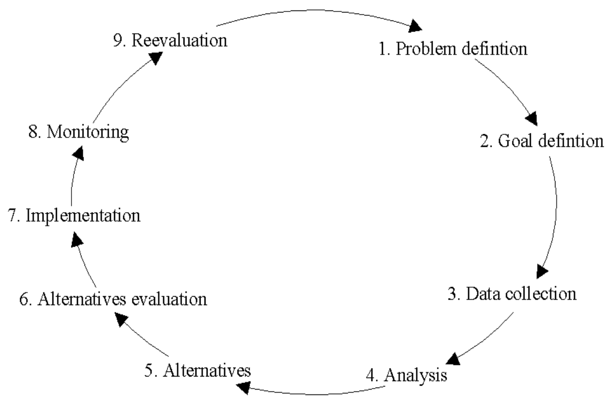


Fig. 2-3 The planning process in the rational planning approach

The main principles in the systematic approach are *the claim of comprehensiveness*, the use of *scientific methods* in alternative evaluation and the application of the so-called "instrumental rationality". Therefore, this approach is also called in the English literature "the rational approach". The subject of rationality will be discussed in a succeeding chapter. The claim of comprehensiveness and rationality in this approach has influenced the use of information in this. It could be argued, that this approach is information based. The following are the main information processes in this approach:

- It starts by the acquisition of adequate body information. Since Geddes formulated the principles of the systematic approach, many planners consider this step of dominant significance. Furthermore, this step in many cases overshadows the planning process. This issue will be discussed in more detail in a later section.
- In attempting to make a decision about different potential solutions or courses of action, planners must communicate their thoughts with different political, administrative and public

bodies. This step presents the main shift from the black box to the transparent-box approach. To externalize their ideas, planners should communicate with others in a suitable form using text, graphics, illustrations, etc. This step is an information-loaded process. It could include political negotiations, impact assessment of the different solutions and public participation.

- After making a decision about the preferable or the agreeable solution, a plan should be produced to communicate the planning results for example to get permissions for the plan activities, and for its implementation during the plan period.
- Then there is the follow-up of the plan where information is collected about the course of the implementation of the resulting impacts of the plan activities. Based on this follow up, a plan review or a new plan will be produced within a specific period.

It is widely accepted among planners in this approach that the ability to make decisions depends, amongst other things, on the availability of information (Devas & Rakodi 1993). In describing the weight that is given for information in spatial planning from this viewpoint, Bracken (1990) argues that information has been and always will be the corner stone of urban and regional planning. This lead in many cases to the belief that, planning is synonymous, not only with preparation of strategy, but also with the acquisition of an adequate base of information (Bracken 1981). In this conventional view of planning where rationality - instrumental, functional or communicative- puts information collection and scientific analysis at the core of planning, it is assumed that a direct relationship exits between the information available and the quality of decisions based on this information.

In this conventional view, planners arrange information in response to questions from decision-makers or to solve problems that decision-makers have identified. This information may include - but is not limited to: surveys, analytical reports, quantitative measures, identification of alternative courses of action and costs-benefits comparisons of these alternatives in terms of feasibility studies, predictions, forecasts and calculations. In this view, it was assumed that the planners' job is to produce such analyses or select and interpret those done by others, and introduce them to decision-makers in a reasonable form, adding nothing beyond a professional opinion about their values and implications. Executives are then to use this information to decide which course of action should be followed. Then, to implement the policy more formal information is used (Innes 1999).

Schönwandt (1999) argues that for the systematic approach to function, planners must have perfect information about: the planning task, the solution alternatives and the consequences of these alternatives. In addition, they should be able to process all this information. Maurer (1988) argues that this approach to planning is based on the hypothesis that it is important, possible and reasonable to cover all types of spatial activities during the so called "the plan-production-phase". He then concluded from the viewpoint of decision logic that, the often-used sequence of work in spatial planning - surveying, problem description, alternatives and plans - is wrong. It is practically impossible in complex situations to define the endless information about the real world, let alone collecting it. This process should be based on a hypothesis about the purpose for collecting this information i.e. for which decision situation are they important. There is no actor - neither an individual nor an institution - who can claim at any moment the possession of a perfect knowledge about the problem situation and the consequences of the actions to be taken.

Although the systematic approach has evolved and adopted the instrumental rationality as a principle, the plan is still its centerpiece and its main tool as in the classical approach. Different types of plans could be found in different countries, in different levels of planning, and in different era, e.g. master plan, zoning plan, etc. Hudson (1979) argues that the rational approach was vulnerable to criticism that its plans never reach the stage of implementation. They are written and filed away, except in rare cases when immense new sources of funding became available to allow the planner to design programs from scratch.

As mentioned earlier, the rational approach tended to use the so called "scientific-methods", hence, one of the main tasks for planning research, in this approach, was developing analytical methods and the corresponding computer programs and models for supporting the planning process. This type of research is found in different writings, e.g. Catanese 1972, Bracken 1981, Meise & Volwahsen 1980. These methods covered a very wide span of application areas ranging from analyses of spatial phenomenon to long-term projections. The application of information systems in this approach was mainly aimed at serving the above-mentioned scientific methods in areas such as:

- Data organization and manipulation: e.g. Geographic Information Systems;
- Evaluation processes: e.g. benefit-cost analysis, operations research;
- Forecasting: e.g. trend extrapolation, econometric modeling, and regression analysis
- Probabilistic models: e.g. Monte Carlo methods, Markov chains, simulation programs and Bayesian methods.
- Judgmental approaches: e.g. Delphi technique, scenario writing, and cross-impact matrices.

The subject of information systems in spatial planning is discussed in more detail in chapter (5).

While this approach has got a lot of consensus for long time, it also has a lot of criticism. Maurer (1988) argues that the rational approach has only functioned when the problem was not more than simple land use restrictions. He argues that the widespread acceptance of this approach emerged from the sequential proceeding, which made the planning process similar to project development. This type of organization allows the usual hierarchies in organizations to be adopted. Hudson (1979) also argues that this approach is well suited to the kind of mandate that has a set of constrained objectives and pre-defined a budget meanwhile it ensures that no one is allowed to stray too far out of line from the mainstream. The higher organizations in the hierarchy determine the priorities and the lower ones should adapt to these situations.

2.2.3. The systems approach "the cybernetic view of planning"

Witnessing the emergence of computerization in all fields of human life, a remarkable thinker, Norbert Wiener, had anticipated in 1950 in his book 'The Human Use of Human Beings' that the automation would liberate the human race from the necessity to do mundane tasks. According to Wiener, human beings have possessed extremely complex communication and control mechanisms for long times – the sort of thing the computer was then replicating. Based on this notation, and others, a new science called Cybernetics was born (Hall 1992). This science suggests that many social, economic, biological or physical phenomena can be viewed as complex *interacting systems*. This ranges from a human cell to a space ship or national economy. Different parts of these systems can be identified; the relations and interactions can be analyzed. Using the suitable control mechanism the behavior of the system could be monitored and controlled against a specific goal set by the controller.

Further developments in the field of cybernetics, enlightened by the rapid development in the field of automation and complex control systems, have suggested that if human arrangements could be regarded as a complex interrelating system, they could be paralleled by similar *systems of control* in the computer, which could then be used to monitor development and apply appropriate adjustments. Essential for this notion to work is the assumption that the controller should clearly understand the characteristics of the elements of the systems and the interactions among them otherwise interfering in a specific part of the system might result in unexpected or unwished effects in other parts of the same system.

The systems view of planning is based on the notion that all sorts of planning comprise a distinct type of human activities, concerned with controlling particular systems. According to this assumption, all planning is considered a continuous process, which works by seeking to devise appropriate ways of *controlling* the system concerned, and then *monitoring* the effects to see how far the controls have been effective or how far they need subsequent *modifications* (Hall 1992).

Spatial planning in this approach would be understood as a continuous process of management and control over a particular system, urban or regional. These systems are interpreted as complexes in which interaction takes place between different social groups (individuals, households, social organizations and businesses). In addition, these social groups interact with the natural environment and with the man-made environment that include buildings for homes, workplaces, and other purposes, means of travel and communication, and facilities and services like parks, schools, and fire protection. These activities and interactions are governed and facilitated by customs, laws, private regulations, agreements, public taxes and expenditures (Harris 1995). Planners are in a continuous state of interaction with the systems they are dealing with. This process could be described as goals-continuous-information-projection and simulation of alternative futures-evaluations-choices-continuous monitoring. This approach concentrates on objectives of the process by developing alternative policies for reaching the objectives of the system. After tracing the possible consequences of these policies, they should be evaluated against the objectives in order to choose a preferred course of action. This process would be continuously repeated as long as the monitoring process shows discrepancy between the planner's intentions and the actual state of the system (Hall 1992). Hence, this approach to planning is based on three basic assumptions:

- The physical environment and the human interaction with it could be described in the form of systems;
- Human behavior could be shaped or controlled by manipulating the physical environment (Naess 1999);
- Assuming that planners have a clear understanding of both the physical systems and the human interaction with it, they would be able, aided by devices that seek to model or simulate the process of development, of controlling these systems (Hall 1992).

All these three assumptions are subject to critical questions concerning their application in urban planning.

- To model a system there must be, to large extents, abstraction and simplification. Many writers following this approach attempted to develop models of the urban system of different levels and countries, e.g. Wilson 1974 and Rondinelli 1985. However, while attempting to apply the systems-view to human societies, to ecological environment and to spatial phenomena, the questions of what should be abstracted and what should be simplified rose. In other words, what should be ignored?
- Attempting to establish a system of spatial phenomena includes the hypothesis that the relations in the spatial context are deterministic. Further, more it assumes that what happened in the past should happen in the future if the same condition exists.
- Regarding the controllable behavior assumption, is it applicable to ecological systems and human societies? Even if it is applicable, who will decide what could/should be controlled and what not?
- In planning and design, planners face problems that have never existed before. How to model something that has never existed before?

Regarding the use of information in this approach, the best analogy that represents the highest level of automation, was the "manned space flight". In an expedition to the moon most of the adjustment to the spacecraft was made not by the astronauts but by an extraordinarily complex computer-control system on earth. This system did not consciously 'see' the spacecraft in order to pilot it. The spacecraft sends information to the control system electronically, and the system responds by feeding this information into models, or artificial simulation, about the course of the spacecraft in relation to the movement of the earth and the moon. The system should then process this information; calculate the correct controls to be applied automatically and automatically apply them (Hall 1992).

If this concept would be applied to spatial planning, the planner would be in a continuous state of information processing and production. Using a computer system, he receives information about the current state of the course of development in the area under control. Then he compares this information with the objectives, which had been defined for the future development of the area. He, thus, evaluates alternative courses of action and selects an appropriate series of adjustments that should be applied to put the region again on course. The alternatives as well as the adjustment actions are information that should be communicated with other parts of the system, human or automated, in order to accomplish the needed adjustment. Such systems could be described as "control support systems" (n-dim Group, 1998). Because of the concentration on achieving the objectives of the plan, the alternative courses of control and taking action to reach these objectives, the plan - in the form of detailed maps - was replaced by written reports.

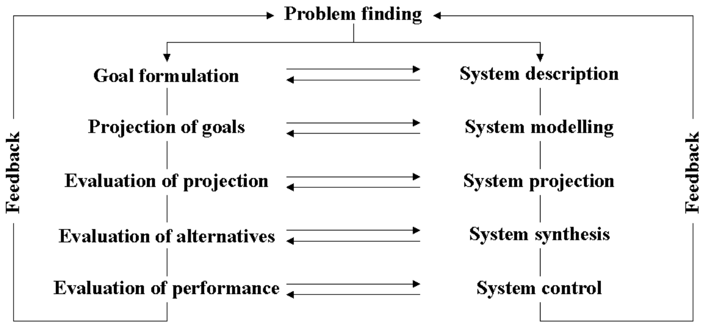


Fig. 2-4 The planning process in the systems planning approach
(modified after George Chadwick in Hall 1992)

Application of information systems in this approach is described as follows "Against the background the planner develops an information system which is continuously updated as the region develops or changes. It will be used to produce various alternative projections, or simulations, of the state of the region at various futures dates, assuming the application of various policies. Then the alternatives are compared or evaluated against yardsticks derived from the goals and objectives, to produce a recommended system of policy controls which in turn will be modified as the objectives are re-examined and the information system produces evidence of new developments." (Hall 1992).

Attempting to implement the concept of artificial intelligence to spatial planning in the form of expert system is based on capturing the experts' knowledge and organizing it into a set of rules in the form of [IF X is the case, then carry out Y actions]. This type of systems in spatial planning was confronted with several difficulties. Attempting to convert planning related knowledge to rules that could be applied to different planning contexts, or even in the same context under different circumstances, is an illusion as a result of the complexity and interconnectivity of spatial planning as well as its political and social dimensions. In addition, the majority of urban planning functions cannot be standardized. To a large extent, they are concerned with decision-making that is based on the virtues of the planning situation or the problem. It is then apparent that such a situation is opposite to the situation in a production line or in a spaceship. Based on empirical experiences in the field of expert systems in spatial planning, Laurini (2001) mentioned that: "much has been done in this direction, but neither totally relevant nor effective approaches appear to exist at this moment." Furthermore, applications of expert systems to spatial problem solving were limited to issues such as site selection, traffic control or the resolution of environmental disputes. However, such researches that have attempted to find out rules for master plan design, Laurini mentioned, have all stopped after few months due to the impossibility of describing the rules of planning in verbal form and due to the difficulty to formulate them as expert system rules. Van Helden (1994) also argues in the same context that spatial planning functions are based more on information supply and analysis systems than on automation and control systems.

2.2.4. Planning as a problem-solving process in a network of actors

The general function of spatial planning is suggesting of spatial structures for the living environment of humans that is ought to be better than the existing one. However, facing the limited resources, and the conflicting interests among the various concerned actors, the realization of spatial development requires overcoming a series of problems and conflicts. A major part of the planners' task is to solve these problems or to find a resolution for conflicts. Hence the planning process includes the following functions: exploring the solutions spectrum of spatial problems, coordination of the spatial activities that have spatial impacts and preparing the actions that are needed to achieve this structure through the time. These functions are aimed at supporting the main task that implies preparing strategies about the spatial development.

To achieve this goal, the planning process is understood as a cooperative process in a network of organizations and actors who have activities with spatial impacts (Scholl 1995). In this process, planners are confronted with imperfect and uncertain objective and subjective information (Maurer 1995). This process should be organized in a way that considers the characteristics of the planning task, the concerned actors and the nature of planning information.

To achieve the goals of spatial planning, the planning process should operate on both the strategic level as well as the operative level. By operating on both of these two levels simultaneously, it attempts to avoid operating on a very abstract level or being lost in a detailed issues leading to fragmented actions without a strategy. Therefore, this process started by preparing an overview about the various activities and decisions that have spatial impacts, to determine the conflicts among these activities. This overview should be common for different actors in the region and it should be updated systematically.

Throughout the problem solving process, planners should consider stepwise proceeding in more than one cycle after each step; they should critically analyze the results of the earlier steps. Stepwise proceeding is important in dealing with spatial problems, in order to find out if the process, so far, is leading to a solution to the problem. Is the case clear enough to make a decision or is there still a need for clarification? Where is more clarification needed? Where is detailed investigation needed? Which options should be followed and which not? This process is called "self-reflection" (Dörner & Tisdale 1993). Self-reflection is important to correct the path of the problem-solving process in order to adapt it to the changing circumstances, adjust it to the new generated knowledge during earlier steps, and examine potential consequences of decisions and actions exemplary on test projects of detailed levels.

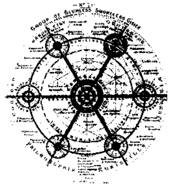
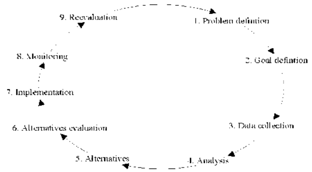
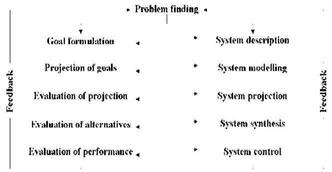
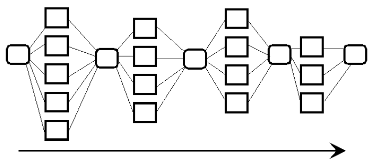
From this point of view, there is a basic shift in approaching planning. Here the planner is not the creative artist as in the classical approach; he is not the scientist and the wise man as in the rational approach, and he is not the technician as in the systems approach. He is, to some extent, all of these at the same time. Nevertheless, mainly the planner is a human being with all the limitations of the human mind. Hence, this approach gives special emphasis to the development of the planning methodology in an attempt to systemize the planning process itself and to overcome the vulnerability of the existing regular planning structures. Then, in this approach, planning is a process of interaction between the planners with his creativity, limitations and characteristics on one hand and the planning situation with its complexity, goals, dynamics, interconnections and interactions on the other hand.

The final plan will not be more than an overview of guidelines, and the detailed decision will be corrected constantly according to the developments (Maurer 1995). During the process, there are different plans such as test plans that examine different solution alternatives regarding the larger scale of planning as well as detailed scale where this presents a chance to examine the applicability of the proposed solution.

Regarding the application of information systems in the action planning, main emphasis is given to developing the tools that support establishing and preserving the spatial overview of ongoing or the planned spatial activities. This overview should be made available for different participating actors in the planning scene to reach a common understanding about the planning context. Common understanding does not mean that all actors must have the same viewpoint but at least they should have the access to the same background. Another application of information systems is concerned with organization and coordination of the planning process itself and the organization of the communication process among the participating actors.

The viewpoint of "planning as a process of problem solving in a network of actors" represents a starting point for exploring the characteristics of: spatial problems, spatial planning processes and planning information as a starting point for defining the theoretical bases for the development and implementation of PIS.

2.2.5. Comparison

Issue	Planning approach			
	The classical	The systematic	The cybernetic	The problem solving
Planning process	Production of plans that give a detailed picture of the desired future of an area.	Survey - analysis - plan - implementation - follow-up	A continuous state of controls over development of an area	A continuous process of interaction between the planner and the planning situation in a net of organizations and actors.
	One-time event.	Periodical process	Continuous control process	Rhythmic process
				
Information	To visualize and communicate the plan.	Acquisition of an adequate body of information. Analysis and projection. Plan visualization.	A continuous information processing and production	Planning information is imperfect. Information is organized in an overview. Information is collected regarding the solution direction and its consequences.
Information systems	Plan production and visualization.	Data organization and manipulation, evaluation, analysis, forecasting	Controls, simulation and control systems	Overview building, Process organization, communication and coordination tools
The plan	Planning is plan production.	Planning is not a plan production but the plan is its centerpiece.	Written objectives and guidelines	The plan is an overview of action guidelines

2.3. Characteristics of spatial problems

From the preceding section, it is clear that in each approach to planning, the role and the use of information is different. It is argued here that the theoretical framework for the development of PIS should consider the main characteristics of planning problems, planning processes and planning information.

In the following section different aspects of spatial problems are discussed that affect the characteristics of planning problems and how these aspects should be considered in PIS. The following aspects will be explored: interconnectivities in the spatial context, the problem-space and the solution-space and the time dimension in spatial problems. After that, different characteristics of planning processes will be discussed. Then, characteristics of planning information that result from the aforementioned characteristics of planning problems, planning process and the human use of information will be discussed. All these aspects should be considered in setting the conceptual and technical bases for the development and implementation of PIS.

2.3.1. Interconnectivities in the spatial context

Spatial planning as a process is aimed at solving spatial problems that lie within the context of a multidimensional interconnectivity such as: spatial, technical, political, administrative, legal and public interconnections. Differentiation of these dimensions of interconnectivity is essential for the development of planning information systems. This importance emerges from the different legal and formal frameworks among which these interconnectivities exist. These formal and legal frameworks influence the information that should be included, the participating actors and the goal of the system. These aspects influence, and in some cases govern, different aspects of the needed system. In this section, three types will be discussed i.e. inter-level, interdisciplinary and inter-regional interconnectivities.

For demonstrating these interconnectivities, a case study of the New Transalpine Railway project NEAT (*Neue Eisenbahn-Alptransversale*) on Switzerland will be used.

a. Inter-level interconnectivity

The first dimension of interconnectivity in spatial planning emerges from the relation between planning on a particular level and other planning levels. This covers both the higher levels of planning such as: federal/national and international and the lower levels such as: local, city and urban planning. This component could be called “inter-level” dimension.

Demonstration: Although NEAT is considered a Federal (national) project; it presents an important component on the European level. It presents an important component of a larger European railway network especially in the north-south axe from Rotterdam to Milan through the Alps and through different European countries within the European Union as well as other counties outside.

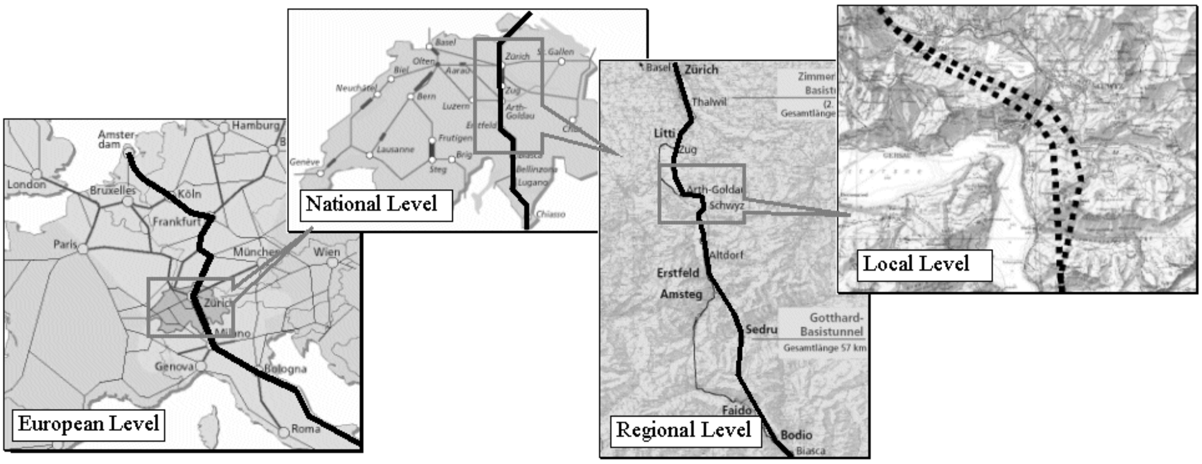


Fig. 2-5 Interconnectivity among planning levels (explanation in text)

On the lower levels, different components of the project are realized on the regional level leading to questions of allocation, i.e. where to allocate this development. Which region will get the benefits in the form of better connectivity, more attractiveness for economic investments, and which region will be disadvantaged by this development in the form of consumption of land, increase of noise and inconvenience through the realization of the infrastructure? In many cases, the impacts of national and regional activities affect towns and cities on the local level. For instance, if the railway line goes near the settlement agglomeration, it will be then essential on the local level to investigate if the line should go through the settlement or should bypass it, or should it be tunneled.

b. Interdisciplinary / inter-actor / inter-sectoral

The second dimension covers the relation between different actors in a specific region, who act, participate, affect or might be affected by the development process. These actors may be classified, but are not limited to political institutions, decision-makers, planning agencies, finance institutions, public management authorities, public and private investors, the residents and different interest groups. The complexity of this dimension could be further elaborated by concentrating only on one of the above-mentioned classes of actors, namely planning agencies. Planning agencies may cover different sectors of spatial planning such as housing, infrastructure, transportation, networks, agriculture, etc. Moreover, planners from sectors such as socio-economic and environment planning. Each of these actors has individual interests, tasks, privileges, and capacities. The importance of this dimension emerges from the fact that each of these actors/agencies has different sector-specific policies which have spatial impacts that are impossible to be limited to the planned sector. These impacts extend directly and indirectly beyond the planned sector. This dimension could be called “inter-actor”, interdisciplinary” or “inter-sectoral” dimension.

Demonstration: An example of this inter-sectoral interconnectivity could be clearly demonstrated in the impact of infrastructure development on the settlement development, taking again the above-mentioned infrastructure development as an example. If the existing network were modified to create a bypass around the city to get rid of the expected extra traffic outside the settlement area, this would have a direct impact on the settlement structure. Existing rail areas and stations will not be needed any more inside the settlement opening new perspectives for the urban development of the area. Meanwhile, the areas around the settlement will be underprivileged by the barrier effect from the infrastructure line and the resulting noise. All these aspects should be coordinated so as to maximize the benefits for the whole settlement and minimize the disadvantages.

Then, it could be concluded that the importance of this dimension results from its direct relation with the success of the development activities both on the level of the spatial cohesion of the entire region and on the socio-economic level in the form of maximizing the positive outcomes of the development process and minimizing the negative impacts.

c. Inter-regional interconnectivities

The third dimension of interconnectivity in spatial planning could result from two aspects. First, the spatial impacts of spatial activities that are considered region-specific while their impacts go far beyond the borders of the region to affect other regions or vice-versa. Second, it could also result from spatial activities that extend across the border of more than one region. This component could be called “inter-regional” dimension.

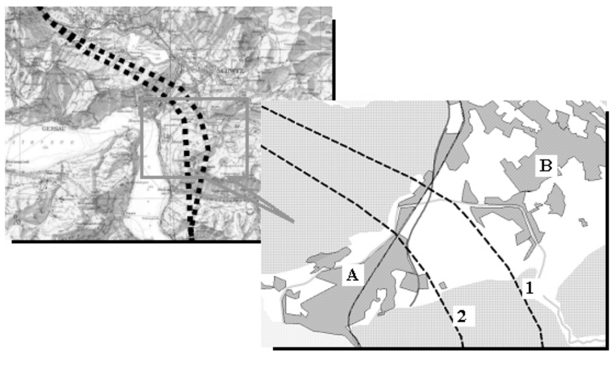


Fig. 2-6 Inter-regional dimension of interconnectivity in planning (explanation in text)

Demonstration: This dimension could be illustrated clearly using an example of a region where a dam will be built on a river. This dam project should be coordinated with the region downstream, as it will affect its water resources and it should be coordinated with the region upstream where the water table may increase. In the railway example, the same line could be located in different alternative paths. For Canton ‘A’ alternative ‘1’ brings the maximum benefits, meanwhile this alternative brings negative impacts for Canton ‘B’. Alternative ‘2’ that minimizes these negative impacts for region ‘B’ requires very high cost and technical complications for region ‘A’.

Conclusion

Interconnectivity in spatial planning is not limited to the above-mentioned spatial dimensions. Spatial activities are interconnected with political, social, ecological, and economic exogenous factors. These exogenous factors influence the results of the planning directly. These variables could not normally be controlled by the planning activities but they can by affected by them.

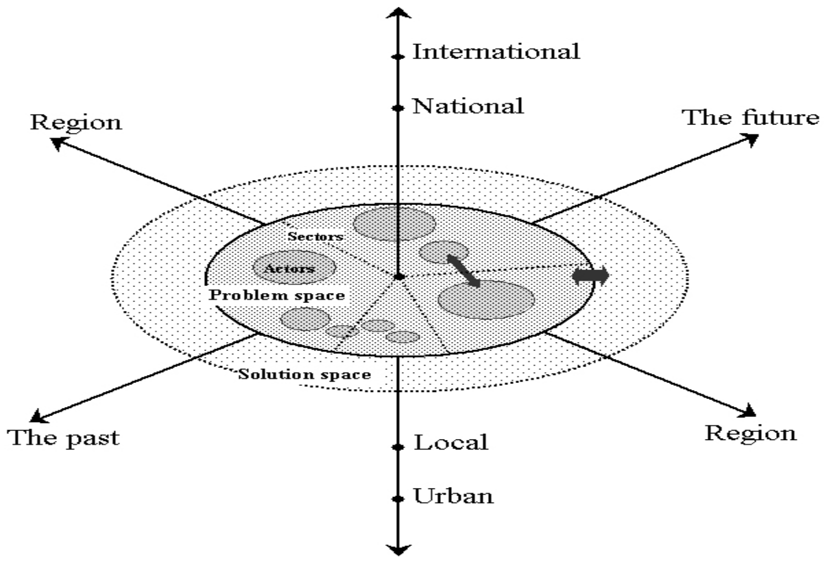


Fig. 2-7 Dimensions of interconnectivity on the regional level

It is important to mention that, not all the above-mentioned dimensions of interconnectivity exit in every planning situation in the same pattern or degree. The degree of interconnectivity in a planning situation is related to the number of dependent and interacting aspects that should be considered in this situation. It is also related to the interconnectivity between the elements or components of the planning context. However, it is not related to the number of aspects or components as far as they are independent. It is likely, that more unexpected side effects and long-term effects of a plan might be overlooked in situations with higher degree of interconnectivity. The degree of interconnectivity is subjective and situation specific. It could not be measured in a specific unit (Dörner 1989). Contrary to the interconnectivity, the scale of a planning situation is related to the number of the affected sides by the planning activities and their consequences.

Because of interconnectivity in complex planning situations, it is also, to a large extent, not transparent. In some cases, this opaqueness results in the form of overlooking important aspects or important interconnections. In some cases, it results in the inability to get the actual state about the subject matter of planning.

2.3.2. The problem-space and the solution-space

The problem-space in a spatial planning process is the field of the reality that planners or decision makers define as the area that should be observed to understand the problem. The problem-space of a problem is not only limited to the physical spatial context, but also includes the time dimension. The time dimension in the problem-space extends in two directions. In the first direction, it extends in the past to the limit to which the problem is observed. In the other direction, it extends in the future to the extent to which extrapolations is needed. The time dimension is discussed in a following chapter. In addition, the problem-space includes different political, economic and social aspects.

The definition of the problem-space is subject to the individual or the group decision of the participating actors. In many cases, the problem-space is governed by the time, capacity and resources available for exploring the problem. If a very wide field is defined as the problem-space, this might result in losing the overview of what is really important or relevant. In this case, the process is overloaded with irrelevant information and too many aspects. On the contrary, if the problem-space is defined very narrowly, it might lead to ignoring important issues that might affect the results of the planning or important relations. Consequently, this might lead to wrong identification of the problem or wrong identification of the solution direction.

The problem-space should not be static throughout the planning process. It could be extended or reduced according to the results of the problem exploration and the decision-making. Meanwhile it could be specialized in specific areas where more information is needed. To minimize the danger of ignoring something important or for using too much irrelevant information, the problem should be observed on different levels of observations with different levels of abstractions.

Although in many cases the problem-space is considered the same as the solution-space, it is proved in many cases that the solution of a problem could be found or at least could be optimized by widening the solution-space of the problem. The solution-space is not limited to the physical spatial context; its boundaries are limited by the limits of all possible fields of action that might lead to solving the problem. In addition, it should include different areas that might be affected by the proposed solution directly or indirectly. In other words, its boundaries are the possible fields of action and the expected fields of consequences. Defining the limits of this space is also subject to the afore-mentioned criteria in defining the problem-space

An example of a solution-space that opens new options for solving the problem beyond the problem space could be found in the case of Südbahn that will be discussed in more detail later (section 6.1). This case deals with the railway line connecting Vienna with the southern parts of Austria. One of the modules of this line has an option going across the border between Austria and Hungary and moving inside the Hungarian territories to enter the Austrian territory again (Fig. 2.8). If the solution-space was limited to the same limits as the problem-space, such an option could not be discussed. Extending the solution-space beyond the problem-space is not limited to the spatial dimension; it might include different political, legal, economic and administrative dimensions. Meanwhile in many cases, these aspects represent the limitations of the solution-space leading to excluding different options.

Fig. 2-8 an Example of the solution-space that goes beyond the problem-space (explanation in text)

The second important aspect about the solution-space might be observed on the long-term-effects and the side effects of the solution. In many cases, aspects or areas that are not affected by the problem itself might be affected by the proposed solution. Limiting the solution-space to the problem space, might lead to overlooking the unwished consequences on other aspects or areas that are not directly included in the problem-space.

Dörner (1989) made a metaphor that illustrates interconnectivity and the boundary of the problem-space and the solution-space. He compared it with a chess game where the player should play with dozens of pieces that are connected together with rubber threads. When he moves one piece, different pieces would move together. Furthermore, some of his pieces and those of his opponent are in fog; consequently, it is difficult to observe them precisely. In addition, other pieces, not only his own but also those of his opponent, are moving according to specific rules that he does not precisely know or just has an incomplete or wrong idea about.

For this complexity, Rittel (1982) describes such a planning problem as a “wicked” problem. A wicked problem is defined as a problem that cannot be definitively described. Hendriks and Vriens (1995) argue that getting a sufficient understanding of both the problem-space and the associated solution-space in such a context suffers from 'technical complexity' and 'social context' of problems. Technical complexity results from the ambiguity in the following aspects. Which criteria are relevant? How these are to be combined? Which actions are reasonable? What may be their results? On the other hand, the social contexts of problems add further confusion to the situation that results from the existence of different or conflicting goals. Such situations are usually associated with the existence of different parties, with different interests, different positions with varying degrees of power within the decision making process and different access to information sources. For PIS to deal with this subject, it should support representing the problem in different levels of abstraction and contexts.

2.3.3. The time dimension in spatial planning

The Latin word "spatium" which means "spatial" also means "time" as it was mentioned earlier. Several aspects regarding time in spatial planning could be identified as following:

- Planning is future-oriented. We live and plan in a four-dimensional space, namely the three dimensional Euclidian space and the fourth dimension is the time. The main task of spatial planning is to define where an activity should be allocated as well as when it should be conducted, either absolutely or relatively to other activities. In addition, planning objectives are always aimed at something that should happen or should not happen in the future. This presents a critical dimension of planning processes regarding the time-lag between defining the problem, developing a solution, making decision, and the realization of the plan activities. Furthermore, the results and impacts of these activities could only be accomplished on the long-term. Consequently, their impacts, positive or negative, could only be determined on the long-term.
- Spatial problems are dynamic. The interconnected aspects and the variables of the system are not statistic; they are changing. The situation as a whole could not be considered as passive. It is active and it has its own dynamics. This dynamic nature of complex planning situation creates time pressure. The circumstances are changing as we are planning.
- The status quo view of the problem situation is not enough to create an overview about the situation. The trend of change in the past is also important. For example if a specific person has 100 Euro today, it will be a different situation to know that he had 200 yesterday and the day before 300, or that he had yesterday only 50 and the day before nothing. However, only looking to the past and making extrapolations for the future is dangerous and mostly wrong (Dörner 1989). It is the same as driving a car looking only in the mirror.

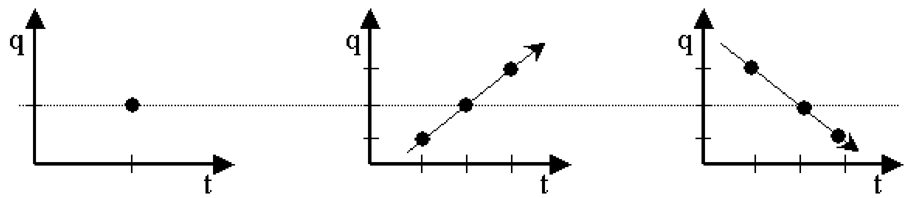


Fig. 2-9 Time as a dimension in observation

- The exogenous variables that affect the planning context may be changing. Goals and objectives in a specific planning situation may vary over time, as may our understanding of alternative solutions, thereby causing a shift in the subject-matter of planning and its resolution (Hendriks & Vriens, 1995). Furthermore, the positions of participant actors may also be changing.

- In such a dynamic context, planning information could not be collected only at the beginning of the process, but planners should keep in touch with the subject matter of planning. PIS should consider this aspect by allowing the updating of the information as it changes. In addition, it should facilitate representing the problem on the time line in a context with other activities that are taking place in the region.

2.4. Characteristics of spatial planning processes

In complex situations as in spatial problems with the described-above characteristics, the knowledge and expertise needed to solve the problem are not available for one person. It is usually distributed over many persons and organizations (Rittel 1982). In such a situation, planners are not experts in the subject matter of the problem but they are experts in guiding the problem-solving process. The planning processes in complex planning situations have, among others, the following characteristics:

- The number of actors that might take part in a complex planning process is large. Scholl (1995) argues that this number ranges from 30 to 50 actors. Furthermore, these actors have differentiated roles and they are spread in various public and private agencies. They are from variety of disciplines and have different backgrounds. In many cases, they have different and in some cases conflicting objectives.
- As mentioned above, the knowledge needed to solve the problem is distributed over many actors. Some of these actors are participating in the process and some are not participating. This distributed knowledge should be shared and communicated among the concerned parties. Rittel (1982) argues that the expertise and ignorance in such a process are distributed over all participants. He argues that there is symmetry of ignorance among those who participate because nobody knows better by virtue of his degree or his status. The need to connect these knowledge and expertise aims at maximizing the knowledge and minimizing the ignorance.
- It was proved that specific social characteristics govern the behavior of human groups in cooperation and interaction where different interests and backgrounds are dominating (Badke-Schaub 1993). It could then be argued that the limitation of a planning organization or a group is the accumulation of its members' limitations plus the limitations of the group as a whole.

Hence, exploration and attempting to solve a planning problem in such a context set specific requirements on the organization of the planning process itself. Such a situation requires the stepwise procedure to minimize the risk of errors although it is not likely to ensure that error will be avoided. In the following sections, these aspects will be discussed, aiming at defining how they might affect the development of PIS and how they should be considered in this development.

2.4.1. Planning process from organizational viewpoint

In complex planning situations, there is no possibility to make the planning process as a routine. In each situation, there are different circumstances that should be regarded. Different courses of actions could be taken in different situations. In addition, the consequences of these decisions are uncertain. In other words, there is no algorithm to solve such problems. Where using algorithm is not possible, problem solving is left to human planners as individuals and mostly as groups.

Bearing in mind that even where routines were set, tested and used; where the most educated and trained scientists were involved; where the highest complicated methods were applied; where the most advanced technology were used, it is evident from many experiences that while human planners, designers and decision-makers were the source of creativity and evolutions, they were also the sources of fatal mistakes that resulted in catastrophes e.g. Challenger, Kursk, Chernobyl, Titanic, Colombia, etc.

However, there is a tendency in public and large organizations to attempt to create operative structures that meets the needs of the tasks in this organization in an efficient manner where rules and routines are established and enhanced and their implementation is differentiated and specialized. However, the detailed the administrative processes are determined and prescribed, the higher the danger of bureaucracy and the less the margin to adapt to the changing circumstances. In such cases, fulfilling the routines and the prescribed procedures become a purpose in itself. The main aim would be to follow up the formal procedures and not to solve the problem. It is then evident that, planning task should be differentiated according to the nature and characteristics of the planning problem. Planning as a general activity includes three types of tasks: routines, projects, and concentration tasks (Scholl 1995).

Regarding the specific characteristics of each of these types, the needed organization of the planning process to deal with them should be defined. Then to determine which tools and processes are suitable for each situation taking in consideration the characteristics of the human planners, human groups and planning situations.

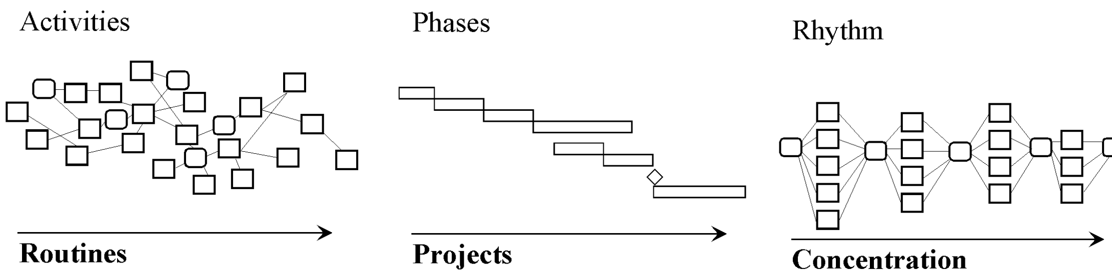


Fig. 2-10 Typology of tasks (Scholl 1995)

If the same methods and processes are used for all types of planning problems and if the exiting strategies and procedures are converted to stereotypes that are applied in all situations, this will result in the what so called 'Methodism', i.e. using well known tools and methods for all problems, without examining if they are suitable for the actual problem and the circumstances, or if they will lead to the defined goal? (Maurer 1993b). In addition, there is also another tendency that is 'Formalism'. It results from concentration on fulfilling formal requirements of laws, rules and regulations, while solving the main problem falls to the background. To overcome the danger of Methodism and Formalism, a planning process starts by setting a general strategy about solving the problem and the goal of the planning process. Then, planning process should be organized in a suitable way for the current problem situation and not just using the same methods and processes to solve all problems. This extends the possibilities beyond the formal planning processes. Some types of problems need planning process that are not limited to the formal ones it requires more innovative processes to solve complex problems and conflicts that are related to a variety of actors and organizations e.g. ad-hoc organizations that attempt.

The used planning information system in each type of the tasks described above should be corresponding to the organization of the process. Meanwhile it should be corresponding to the organizational structure. It should also support connecting the participating actors, facilitating information processing and communication according the process organization.

2.4.2. Objectives and goals in spatial planning

As mentioned earlier, there is no planning without an objective or more. Any spatial planning situation should also have an objective or more. By having objectives, spatial planning is normative in nature, it has a view to things that 'ought-to-be' something different other than the actual state – the 'is-state'. This normative view of spatial planning differentiates spatial planning from other spatial sciences that have only a positive view to the space. Such sciences describe only the 'is-state' without attempting to influence it. Objectives in spatial planning have the following characteristics:

- The general objective of spatial planning is mostly related to providing a spatial structure of activities that is assumed better than the existing pattern or better than the pattern that might exist without planning.
- In different planning situations, different objectives are stated. Objectives in spatial planning range from allocation of activities, facilities or infrastructures and optimizing the relation between these elements in space on one hand and assessing the spatial impact of different policies on the other hand. Maurer (1988) extends the objectives of spatial planning to explore potentials and conflicts of space. Several variations, subclasses and synonyms of this general objective could be found.

- Most of these objectives are human-centered. They aimed either at facilitating a human need or at changing a human behavior.
- Goals and objectives of planning could be stated at various levels of abstraction. In some cases, objectives are stated in a very abstract level, e.g. making a city livable. On the contrary, it could be stated in a very concrete level e.g. planning a residential area for a specific number of inhabitants. Objectives in spatial planning might have a large scale, e.g. making a city competitive on the international level to attract more investments. In such a case, objectives should be divided into sub-objectives that are possible to be planned.
- The objective of spatial planning is not only to describe the end-state or the wished-state. It should search for ways to overcome the difference between these two states. It is not enough for spatial planning to propose wished future without providing ways to reach it.
- Most of spatial planning activities have various and sometimes contradicting objectives. In the afore-mentioned railway example where multiple objectives exist, different pairs of contradicting objectives could be identified. For example while decreasing the travel-time was a prime objective for the whole system, adding more stops was considered an important objective for other actors on the regional level, so as to increase the accessibility for many inhabitants as possible. Another contradicting pair of objectives is increasing the capacity of the railway line to maximize the number of running trains per day while keeping the noise on an acceptable level. A third pair is the removal of the railway path to bypass the agglomeration area meanwhile avoiding devastating the landscape. In such cases where multi-objectives exist, the complexity of the planning situation increases as a result of the competitive existence of more than one problem-space and more than one solution-space simultaneously (Hendriks & Vriens 1995). To overcome this contradiction among objectives it might be essential to change the sub-objectives, to define a balance or to set priorities (von der Weth & Strohschneider 1993)
- Another important aspect regarding the objectives in spatial planning tasks is the relation between the scale and the complexity of the task. Hall (1992) argues that, there is neither negative nor positive essential correlation between the scale and the expense of a planning program on one hand, and the complexity of the objectives behind on the other hand. For example the American moon-shot program, one of the costliest investments in the history of mankind, had a fairly obvious single main objective

2.4.3. Planning and the plan-making

The importance of discussing this issue emerges from its consequences for PIS. If planning is the plan making, then a planning information system should be mainly aimed at supporting the plan making process and all the tasks related to it. On the contrary, if planning is not only the plan making, then the plan will not be the core of the planning information system. Other information activities should be considered.

There are three main views regarding the relation between planning and the plan.

- There is the blue print approach where planning is the plan making (e.g. Geddes).
- Contrary to this, another position assumes that planning does not essentially need the plan. In this context, it is argued that the goal of planning is to achieve the desired effects and not to produce plans. There is good planning without a plan. This position is not limited to spatial planning, e.g. the famous U.S. general Dwight D. Eisenhower (1890–1969) said, "In preparing for battle I have always found that plans are useless, but planning is indispensable."
- Between these two positions there is a third position, which agrees that planning is not a plan making process, but it needs the plan. Supporting this position, Hall (1992) argues that it is impossible to think of spatial planning without some spatial representations. In this position, a "plan" could be a very precise and detailed map, or a very general diagram.

Regarding the intensity and the level of details in preparing any plan, two extreme situations might arise, namely "over-planning" and "under-planning". Over-planning occurs when the plan is prepared to a very detailed level. Although each eventuality would be considered in this case, the real action could be delayed or hindered as a result of an unexpected factor. On the contrary, "under-planning" occurs when actions are not connected to each other and the proceeding is without strategy. There is no clear thread between different planning subjects. All actions are reactive and no single subject is brought to an end. (von der Weth & Strohschneider 1993)

2.5. Characteristics of planning information

2.5.1. A definition of planning information

Planning information in general could be defined as any information needed, processed or produced during a planning process. In applying the definition of information in the sense discussed in chapter (1), it is important to study "planning information" considering the twofold definition of "information" as a message and as a process. In the first fold, planning information are messages concerning the planning problem or the context of the planning process that deals with this problem and changes the recipient's knowledge and/or uncertainty; these messages could be from any source. In the second fold, the planning process is defined as the processing and the production of information about a specific planning problem or for the context of this problem. This covers all the messages that would be processed or produced throughout the planning process. In this context, Rittel (1982) argues that planning could be understood as a process in which the problem relevant information could be produced and processed.

2.5.2. Main features of planning information in complex planning situations

Facing complex problems or conflicts, planners and decision makers have only an imperfect knowledge about the subject they are dealing with. Imperfection is a result of incompleteness and uncertainty of this knowledge. At the beginning of a problem solving situation planners have only a partial knowledge about the subject. Meanwhile, the certainty of large parts of the information and the knowledge, which they have, is not entirely guaranteed. Incompleteness and uncertainty of planning information could be attributed to different reasons. The following are some of these reasons:

- Information about the world is partial and uncertain,
- Planning information is originated from different sources in different forms and languages,
- The accuracy of this information is limited,
- Information is not static it is changing,
- The knowledge about the available information is also partial.

On the first level of observation, planners have *partial and uncertain knowledge* about different aspects of the world such as; a) the knowledge about the existence of objects and the occurrence of events in the world, b) the knowledge about the relationships among these objects and events, and c) the knowledge about the rules that govern the behavior and interaction of these objects and events

The second source of imperfection and uncertainty in planning information emerges from the *variety of languages* that are used in preparing and communicating this information. This variety of languages is a result of the multi-disciplinary nature of spatial planning. This aspect will be discussed in more detail in a following section.

The third reason is attributed to the *unavoidable loss of details* by abstraction of information, which results from the simplification and generalization that are essential in coordinative activities. This leads to limited accuracy in the objective knowledge and more limited accuracy in the subjective knowledge about a planning situation (Maurer 1988). In this case, the creditability of this information is questionable.

The fourth reason is related to the fact that *the world is not static*. As planners attempt to understand real life problems, the nature and the characteristics of the problem, the "real issue," continues to change. Consequently, the precision of planning information decreases quickly. Meanwhile, the knowledge about the problem or the subject of planning or design evolves by attempting to solve the problem or to work out the subject. This evolution continues as long as the project or the process does (Conklin & Weil 2000). Hence, planning information is temporarily up-to-date. Its half-live period ranges from 6 to 12 months (Maurer 1988).

On a different level of observation, *what we know about our knowledge* and ignorance is less than what we do not know. Although people usually think that they know what they know and what they do not know, there is a larger part of ignorance about what they do not know (Fig. 2.11).

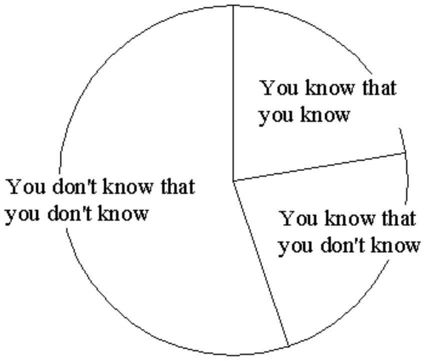


Fig. 2-11 Knowledge about knowledge in complex planning situations (Scholl 1995)

2.5.3. The planners' use of planning information

Facing these characteristics of planning information, planners have regarded the acquiring of a sufficient body of data, properly transformed into relevant information as of major significance since Geddes first formulated the systematic approach to urban planning, 'survey - analysis - plan'. This lead to the popular misconception that: solving planning problems can be achieved in some way by the mere accumulation of factual information. However, attempting to collect information without any hypothesis about the purpose of this information or the solution direction for the problem leads to observing information collection as a goal in itself. Bernstein (1996) described this tendency as follows "The information you have is not the information you want. The information you want is not the information you need. The information you need is not the information you can obtain. The information you can obtain costs more than what you can pay" (in Bracken 1981). Consequently, collecting and processing information have become major time-consuming tasks in many planning situations that in many cases overwhelm the planning task itself. In many cases this tendency is governed by the rule "You never know what is enough until you know what is more than enough." as the English poet William Blake (1757-1827) once said.

The collaborative nature of spatial planning opens the possibility to use accumulative knowledge of all the members of the group for a better understanding of the initial state of the problem. However, as the amount of accumulative information of the group increases, the transparency of this knowledge decreases. Furthermore, as a result of the volume, the diversity and the actuality of the information that is communicated, collected, channeled and distributed among actors in a spatial planning process immense resources are devoted to these information processes.

Bearing in mind that planning information is neither perfect nor comprehensive, the amount of collected information does not essentially mean better understanding of the subject of planning or a better chance for a better solution of the problem. Using large amounts of knowledge and information that have built-in levels of imperfection and uncertainty results in the so called “information indigestion” and sometimes “information poisoning” (Rouse 1992). It is important then in any planning situation not to equate "more" information with "effective" information (Bracken 1990). It is evident in many cases, that failure in planning is not the result of the lack of knowledge, capacity or advanced methods but it results from what Maurer (1993a) called “elementary ignorance”. Elementary ignorance happens when planners and decision-makers overlook basic and essential issues, for example, when they accept the received information without evaluating its creditability by comparing it with information from other sources. This applies specially to information that results from complex analytical models, which have different integrated levels of imperfection, and forget using basic common sense to review and criticize these results.

Nevertheless, planners and decision makers usually argue that the tendency to collect additional information is aimed at enlightening the dialogue so that all of the parties in a debate will reach a better solution of the problem or a better resolution of the conflict (Gottsegen 1995). However, planning in general as well as in complex situations, as a human cognitive activity, is governed by physiological factors of the human mind: in thinking, processing information, problem solving and decision-making. Based on analyzing the human capacity and behavior in problem solving situations, both in experimental form as well as in real situations, these limitations are empirically documented in different writings[*]. Based on several experiments, Schönwandt (1999) raises an argument against the argument of “more information for better solution”. His argument implies that the tendency for collecting more information is characterized by an addiction to search for the information that supports the adopted hypothesis and to ignore the information that contradicts with this hypothesis. Consequently, searching for further information would be earlier stopped if the wished results are achieved. He also argues that the evolving knowledge in a problem situation does not essentially lead to a better decision, as decision-makers attempt to support their earlier positions, which they have formulated under information deficiency regardless of the evolving knowledge. In these experiments, unwished information has been totally ignored, disregarded in an early stage or has been devaluate.

From a different point of view, information plays an indirect role in planning by becoming embedded in the thoughts, assumptions beliefs and values of decision-makers, planners as well as community members, thereby influencing their problem definitions and hence their actions. Innes (1999) argues that instead of saying that decision-makers and planners consciously use information to make a choice, it is more accurate to say that their information frames limit the available choices.

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[*] e.g. Miller 1956, Schönwandt 1986, Dörner 1989, Strohschneider & von der Weth 1993, Tenner 1996 and Hussy 1998.

2.5.4. Rationality and planning information

For the development and implementation of PIS, the characteristics of planning information and the planner's use of information in complex planning situation should be considered. While it is irrational to ignore them entirely, attempting to eliminate them is unreasonable. The rationality of spatial planning is based on how this imperfect and partial information is handled (Maurer 1988). Hence, aspects such as the perfection, certainty, precision and creditability of planning information should be dealt with.

a. Facing the imperfection of information in spatial planning, it is not reasonable or possible, in any problem-solving situation, to aim at getting a perfect knowledge about the situation before attempting to solve it. However, it is important not to forget or to overlook an essential issue. Hence, important and relevant information for the problem exploration and the problem solving should be organized in a way that facilitates getting an overview about the situation for the concerned actors.

b. Further information should be collected or generated, based on hypothesis about the needed clarification of the problem situation or about the alternative course of action for solving the problem. During the planning process, information is produced in the form of explanatory documents or solution proposals. By exploring this information, further information would be collected where more clarification is required or where the circumstances or consequences in respect to a specific alternative should be examined. Taking in consideration the limited time and resources that are normally available in any planning process, it is an important task for planners to decide which information is needed and for which purpose.

c. There is information that exists, and information that must be generated through various researches through different participative and consultative processes with other actors inside and outside the process. It is another important part of the planners' role to decide which information could be obtained or generated regarding the available resources and how this could be done efficiently. PIS should support the identification of available information from that needed for solving the current problem.

d. Information that exists is normally explicit and documented. However, a large part of information in planning is implicit. It is saved in the heads of different actors. It is an important task for PIS to make the available explicit knowledge accessible with minimum effort and cost for the participating actors by interconnecting this information from the different sources. Then to facilitate externalizing the implicit knowledge and to convert it as far as possible into explicit.

e. Planning information includes both objective and subjective information. Objective information is the information that could be produced or understood in the same way independent from a specific person and leading to the same results. Subjective information is consequently the information that its origin is directly associated to a specific person. It is important to emphasize that the differentiation between subjective and objective information is not related to the truth of the information content, it describes just how this information is produced.

f. Regarding the rapidly loss of actuality and precision of planning information, planners and decision makers need to update their information systematically. PIS should facilitate updating information in a relatively minimal effort and keeping the participating actors in contact with the current state of information.

g. Planners should examine the creditability of their information be comparing information from different sources with one another to check inconsistencies and contradictions, hence, to produce more plausible information (Maurer 1988). This requires that planners should use active information processing behavior rather than a passive one. PIS should facilitate exploring the same information in different contexts and representations. It should also allow associating of different pieces of information.

2.5.5. Language in planning information

In the simplest description, a language consists of symbols and rules scheme that governs the usage and the understanding of these symbols, i.e. words and grammar. In this sense, language includes all types of coded messages, graphical representations, arithmetical equations, algebraic formulas, etc. In general, communication should be in the everyday language. However, the everyday language is loaded with feelings, associations, and connected with images. It is thus clear that ambiguity in using language starts at the same moment when a person starts capturing his thoughts, observations and experiences. It increases when he attempts to express his preferences, intentions, and positions.

Argumentation, communication and coordination about decision alternatives, circumstances, probabilities, and consequences of actions are only possible by means of some sort of language in the above-mentioned sense. However, the use of language in spatial planning is governed by different characteristics of the spatial planning.

- Since the territory of spatial planning - by nature and legislations - is multi perspective and interdisciplinary, therefore, information that is processed or produced in a planning situation is from various professional backgrounds, e.g. legal, social, ecological, engineering, and political, etc. Consequently, it is in different forms e.g. laws, regulations, norms, studies, statistics, surveys, questionnaires, interviews, plans, decisions, recommendations, notes, announcements, etc. Furthermore, several languages are used in the same planning context regarding the different backgrounds of the participants. There are several professional languages from different disciplines, political language, and colloquial language as well as planning jargon.

- This information is assembled in different formats e.g. tables, maps, texts, photos, etc. and are saved in digital, electromagnetic or paper forms.
- The planning process is collaborative and involves a large number of actors that would participate, affect or be affected by the outcomes of the planning. Planning information is characterized by being from different sources. It is produced by different individuals or organizations with different qualities and often using different standards.
- In addition to the above-mentioned complexity, there is the variety of the systems, the methods and the procedures that are used by these actors.

Since the mutual understanding among communicating actors is limited in general by their common language, it could be argued then, that these limitations are more complex on mutual understanding in spatial planning. Considering these aspects, it is obvious that everyday language is not enough for describing planning problems, solution alternatives and decisions. It is observed in different planning and design situations that most complications in the process of information flow result from the difference in standards and structure of information sets that each actor uses and stores (n-dim Group 1998). In other words, the absence of both the components and the rules of a common language hinder information and communication in spatial planning.

Maurer (1988) compared this situation with the Tower of Babel where much is said, but a common understanding in never reached, as each actor is talking in his own language. This complexity consumes a lot of time and effort to just combine these different information sources or even make an overview about its content, let alone to collect it. If an actor is not able to interpret the received information, this information will be considered as non existing, irrelevant, or not understood and consequently will not be considered while making decisions.

It is essential then for the development and implementation of PIS to set the foundations of a common language that should help in overcoming these complexities and facilitating different information processes in spatial planning tasks.

2.6. Conclusion

- In all approaches to planning, information plays a critical role throughout the problem-solving and decision-making cycle. It is used in identifying problems, developing proposals of solution, argumentation about the proposed solutions, action formulation, implementation and coordination of spatial activities. However, the role and the use of information in the planning process is a reflection of the theoretical approach that is adopted in this process.

- The following aspect should be considered in the development and implementation of PIS in complex spatial planning situation:
  - ∗ Characteristics of spatial problems,
  - ∗ Characteristics of spatial planning processes,
  - ∗ Characteristics of planning information,
  - ∗ Characteristics of human beings in processing information.
- Regarding the nature of spatial subjects in complex planning situations, the following aspects should be considered:
  - ∗ In complex planning contexts, there is a high degree of interconnectivity among different levels of planning, sectors, actors, and regions. All these interconnectivities are not well known in advance.
  - ∗ Spatial planning subjects are not static; they are changing through time.
  - ∗ There is a time lag between making a decision, the implementation of the actions of this decision and the outcomes of these actions.
  - ∗ There is also interconnectivity between the problem space and the solution space. The side effects and the long-term impacts of spatial activities may extend beyond the wished outcomes and the targeted space. They are unpredictable in many cases.
- Regarding the characteristics of planning processes the following aspects should be considered:
  - ∗ Planning processes in complex planning situation could not be considered as a plan making process; it is a continuous process of problem solving and conflict resolution.
  - ∗ These processes are mostly conducted in a group of individuals or a group of organizations with different backgrounds, views, interests and responsibilities.
- Regarding the main features of planning information, the following characteristics should be considered:
  - ∗ limited accuracy,
  - ∗ changing and losing precision rapidly,
  - ∗ originated from different sources and in different media types.
- These aspects play an important role in setting the conceptual and technical criteria for the design, development and implementation criteria of PIS.
- In each planning situation, these aspects should be studied before deciding the structure of the required system: a) the interconnectivities and dynamics of the planning subject, b) the organization of the planning process, and c) the nature of the needed and the available information for this process.

3. A Typology of Planning Information

Any message that is processed or produced during a planning process that changes the recipient's knowledge or uncertainty is considered planning information. In this sense, planning information covers a wide range of information. It covers not only information describing features of the world and information about plan actions but it covers also information about the alternative courses of actions, information about the planning process, specialized information of planning as a discipline, etc. These types of information are communicated among large number of actors that have different backgrounds, different roles and different interests. This information is processed or produced in a variety of information processes. Setting an order or a typology for planning information is considered a first and an essential step towards laying out the conceptual framework for PIS. This typology is based on a basic argument that implies that each type of information is used, processed or produced in information processes. These information processes take place in a variety of planning information domains. These three concepts, i.e. information domains, information processes and information objects are argued here to be crucial for the development and implementation of planning information systems.

These three concepts represent three levels of abstractions or three viewpoints of observation. The concept of information domains is an abstract level of observation to establish the overall view of the main areas where planning information is used or processed. The concept of planning information processes is a procedural observation to identify the main processes in which planning information is used, processed or produced. These processes might take place inside one domain of information in the spatial planning process, or between different information domains. However, an information process might take place between spatial planning as a super information domain and other information domains such as the political domain. The concept of planning information objects is based on an analytical observation to define the main objects of planning information and the interrelations between these objects. In other words, it could be stated that there are information objects that are processed or produced in different information processes in or between different information domains.

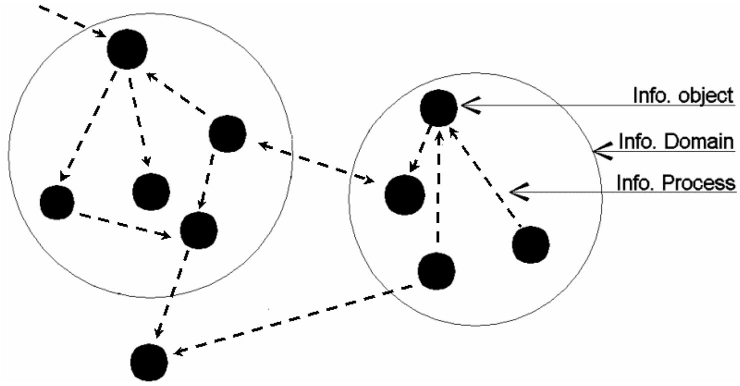


Fig. 3-1 The concept of information domains, processes and objects

To set the above-mentioned typology this chapter is an attempt to discuss the following questions:

- What are the main criteria that should be considered in identifying planning information domains?
- What are the main information domains in spatial planning?
- What are the main information processes in spatial planning? What are the main characteristics of each process?
- Is there a set of common information objects that are often used in different planning processes? What are the main characteristics of each of these objects?
- How should these domains, processes and objects be considered and implemented in PIS?

By identifying the main domain, process and object of planning information, it will be possible to define the requirements that are needed to handle the different types of information according to its characteristics, the rules to use it and its location in the planning process. However, this typology is neither static nor comprehensive. It is neither possible nor reasonable to identify and describe all items of spatial planning information. In addition, the items of this typology could be changed or extended according to the planning situation.

Introductory remarks about information modeling

From information systems' point of view, information modeling is considered a basic step in establishing an information system that supports information processing in a specific domain. After distinguishing different classes of objects in these domains, their attributes and relations, the information model for this domain will take the form of a comprehensive model for information in this domain.

In information systems, there is a claim of comprehensiveness in establishing information models. However, a comprehensive model or a global classification, in this sense, for information in spatial planning is not possible, unneeded and even unreasonable. In different planning situations, different classes of planning information will be important regarding the characteristics and the organization of the specific planning contexts. The proposed typology in this research is therefore partial. In other words, the aim of this chapter is to draw the core and the outlines of such a planning information model that could be extended or customized regarding the planning context.

Some information systems that were applied in planning and design processes have attempted to make an abstract structure of the information model for the planning and the design processes. This abstract model attempted to focus on a single type of information entities. These systems attempt to steer all types of information to fit in the mono-dimensional information model. The following are few examples of these types of information systems e.g. Agent Oriented Information Systems, Task-oriented Information Systems, Event-oriented Information Systems or Issue Based Information Systems. Another major application that could be classified under this category is "Spatial or Geographic Information systems" which concentrates merely on the spatial elements as the core elements of the information system. While these approaches proved relative success in some situations, they could not be the bases for a planning information system that attempts to support different information processes in planning.

Hence, it is argued here that instead of attempting to establish a model for planning information, an object language that supports the definition of different domains, processes and objects of planning information is more reasonable. This language should serve to overcome the problem of the lack of a mutual language among heterogeneous actors and to set the base for efficient planning information flow processes. This language should have clear elements and rules meanwhile it should also be easily extended and adjusted. It should have the possibility to include specialized knowledge and detailed investigations (Maurer 1988).

3.1. Planning information domains

Identifying planning information domains is based on three main groups of characteristics that distinguish information objects and processes in each of these domains.

- The first group is related to the information objects in this domain regarding the content, the coverage, the life span and the target group for each of these information objects.
- The second group is related to the information processes that are needed and used in each domain.
- The third group is related to the participating actors in information processes in this domain.

These three groups of criteria influence directly the rules that should be applied in each of these domains and the functions that are needed to deal with each class of objects in each domain.

The concept of planning information domains is applied on three levels of abstraction. On the highest level of abstraction, spatial planning is regarded as an information domain that is related directly or indirectly to other information domains such as the political domain, the social domain, the urban management domain, the economic domain, etc. On a lower level of abstraction, different information sub-domains could be identified in the spatial planning domain. In each of these information sub-domains, different information objects and different information processes could be outlined. These objects have interrelations within their domain as well as with other objects in other domains.

The following paragraphs include a short introduction to the concept of Ontology. Then a discussion of the identified information domains in spatial planning will be introduced. Each of these domains will be discussed in details after that.

Ontology as a base for identification of planning information domain

One of the important concepts that are used in defining the information domains in spatial planning is the concept of "Ontology". Ontology is a Greek word that means "the science of being". It refers to the branch of philosophy dealing with the nature and the relationship of/amongst beings. The most widely used definition is "An ontology is a specification of a conceptualizations". The concept of Ontology is originated and was used in philosophy for several centuries. In the last few decades, it got a lot of interest in the field of information systems, artificial inelegance and knowledge sharing. In these fields, it is interpreted as: "A systematic account of existence". Guarino (1998) defined Ontology as "a hierarchically structured set of terms for describing a domain that can be used as a skeletal foundation for a knowledge base" In this sense, Ontology is an explicit formal specification of how to represent the objects, concepts and other entities that are assumed to exist in some area of interest and the relationships among them.

Using a declarative language, Ontology represents the set of objects that could be found in a specific domain. This set of objects is then called the universe of discourse. Ontology is classified into four types (Guarino 1998):

- *Top-level Ontology* describes very general concepts that are independent of a particular problem or domain e.g. space, time, action, etc.
- *Domain Ontology* describes entities used in a generic domain e.g. hydrology, traffic, city planning, etc.
- *Task Ontology* describes a routine task or activity e.g. task assignment, meeting coordination.
- *Application Ontology* describes concepts depending both on a particular domain and on a particular task. These concepts often correspond to roles played by domain entities while performing a certain activity.

In this sense, Ontology is helpful in establishing the needed typology. It emphasizes the concept of shared and common perception of domains of knowledge and the objects in a specific domain, which facilitates communication of information among different participants in this domain. Hence, this concept could be implemented to distinguish the different domains of information and knowledge in planning. In addition, the concept of domains will facilitate the identification of the main sub-domains of information that exist in any planning situation as well as the objects that could be found in each of these domains.

Planning information domain

On the highest level of abstraction, spatial planning could be regarded as a domain among many other domains, e.g. public administration, economy, etc. These domains are related to spatial planning either directly or indirectly. These relations are not static. They change over time and are different from one country to another.

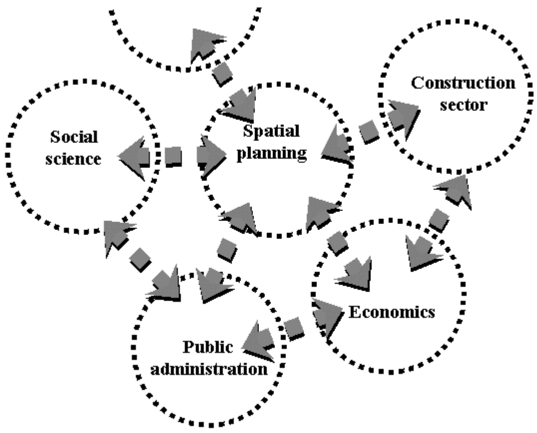


Fig. 3-2 spatial planning as a domain in a larger network

If spatial planning is observed as a super-domain, several sub-domains could be identified. Different approaches to identify its sub domain could be applied. The first approach is the classical approach which is discipline oriented. In this approach, spatial planning domain would include sub domains such as city planning, traffic, housing, infrastructure, etc. However regarding the interconnectivity of spatial planning that was discussed earlier, this classification is needed but is not enough. For example, in planning the earlier mentioned high-speed railway line, but it is not reasonable to consider individual aspects of the spatial planning. In this example, the traffic planning is related directly to spatial development. Its impact will affect other fields of infrastructure, housing, etc.

Based on the three groups of criteria that are mentioned above, namely: the types of information objects in a specific domain, the information processes that take place in each domain, and the types of participating actors in each domain, three domains of information could be identified in spatial planning as follows:

- The subject matter of planning domain includes information objects about features or things of the real world. These features or things present the subject of the planning or they are related to the subject of planning,
- The process domain includes information objects that are related to a specific planning process which deals with a specific subject-matter, and
- The planning-knowledge domain includes information objects that are mostly specialized knowledge. This knowledge exists independent of a specific planning situation. It includes information objects such as laws, regulations, methodological knowledge, etc.

The relationship among these information domains in planning could be described as follows: a) a planning process is organized to handle a specific planning matter, b) the subject-matter domain presents the primary input to the process domain, c) during the process, knowledge from the planning-knowledge domain would be utilized to propose alternative solutions and then decide the preferable course of action, d) the output of the process domain would be the proposed solution, e) this solution should be externalized to the implementation domain, f) actions in the implementation domain might change the nature of the subject-matter by implementing the actions of the plan, and g) it might also affect the planning discipline domain by creating new knowledge or theories of planning.

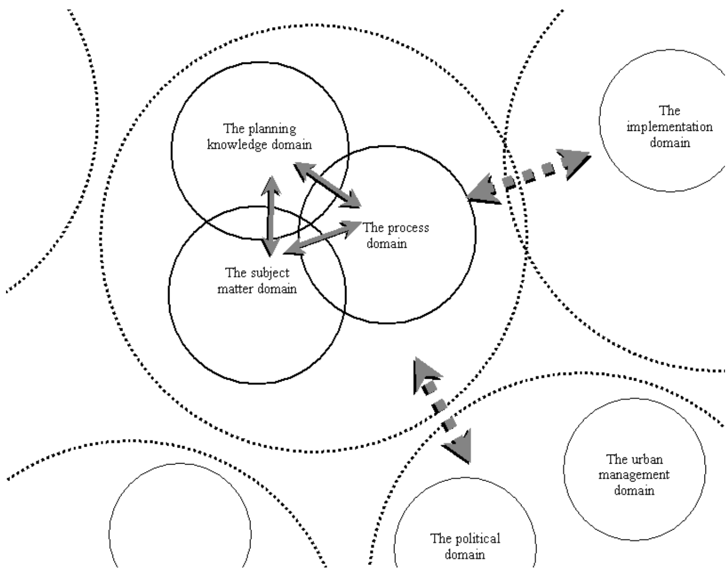


Fig. 3-3 Information domains in planning

Each of these domains will be discussed to define the different types of information that are processed or produced in the domain. This step will support the identification of the specific requirements in PIS to deal with these types of information and to support information processing in this domain.

3.1.1. The subject-matter domain

The subject-matter domain of planning includes information objects that are related to features or things of the real world in a specific spatial context, a problem, a conflict or a subject. The subject matter of a planning process could be in local or global context. Information objects in this domain are not only limited to descriptive information about geographical features of the world, but also cover ongoing activities, problems, conflicts, potentials and actors in an area. Most of these information objects are about things or features that exist physically or logically apart from any planning process. However, it might include information objects about the alternative solution of problems and about resolution proposals of conflicts. Most of these information objects could be related to more than one planning process.

Information objects in this domain could be classified into empirical, analytical and normative information. More advanced combinations of these objects are needed to understand the relations and the trends of these primary objects. Among these elements are the spatial overview and the chronological overview. The following paragraphs include a brief discussion of each of these types. This discussion is aimed at identifying the specific characteristics of each of them. This identification will facilitate the needed functionality and the essential criteria that should be considered in the development and in the implementation of PIS.

1. Empirical information objects

Empirical information objects are information objects about physical or logical elements of the real world related to the subject-matter of planning e.g. natural or artificial features, problems, etc. They also include elements related to the context of the subject matter of planning including projects and activities that might affect, be affected by, be complementary to or contradicting with the subject-matter of planning.

Empirical information includes information objects about 'what is', 'what was' or 'what will be' the case. This type consists usually of empirical statements in the form '*x is y*', '*x was y*' or '*x will be y*'. Regarding spatial phenomena, this type of information deals with - but not limited to - physical, chronological, social economical or ecological issues. If a specific discipline is solely concerned with this type of knowledge, it should then be considered a branch of geography.

In other classifications (e.g. Rittel 1982), this type was called "factual" knowledge. I prefer to call it empirical in the sense of 'originating in or based on observation or experience' instead of 'factual' in the sense of 'restricted to or based on fact', where fact is defined as 'a piece of information presented as having objective reality'. (Definitions are based on Merriam-Webster Collegiate Dictionary). In spatial planning as in the real life, many observations and experiences inherit some level of uncertainty e.g. people have considered the assumption that the earth is stationary, and that the sun is moving around it as a fact for hundreds if not thousands of years.

For understanding and exploring spatial problems, empirical knowledge must be generated from huge amounts of data and information. In many cases of spatial planning this type of knowledge is overshadowed by data and information.

a. Information objects about spatial features:

Information objects about spatial entities are pieces of information about things that exist in the real world in a specific spatial context. Spatial objects have a unique characteristic namely that they are spatially referenced. Hence, spatial information objects are related to or referring to a spatial entity including natural, artificial, virtual and conceptual elements. Natural and artificial (man made) spatial entities are physical things that exist in the real world. While virtual and conceptual entities are non-physical features.

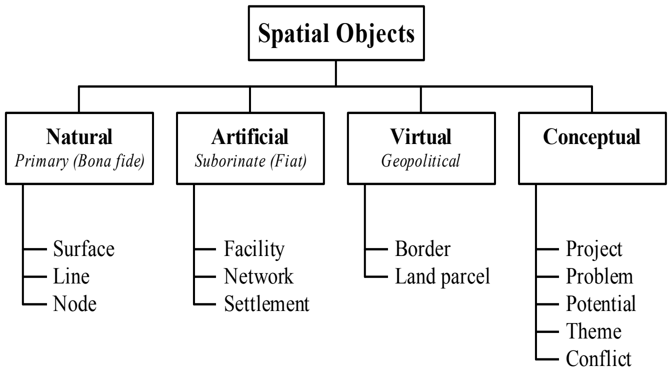


Fig. 3-4 The subject-matter domain > Empirical information > Spatial information objects

- *Natural features* are considered the primary spatial objects, as they exist in the world independent of any other spatial feature or any other classes. The objects that are included in these classes are called *bona fide,* which means real. This class includes all natural features e.g. rivers, forests, mountains, etc.
- *Artificial features* are considered subordinate spatial objects, as their existence is based and related to other spatial and social entities. The objects that are included in this class are called *fiat*. This class includes all man-made physical features such as settlements, networks, roads, etc.
- *Virtual features* are features that are not physical but very important for the planning, e.g. geopolitical and administrative subdivisions. They are, normally, well defined on maps and have references on the ground. They have in many cases power by law.
- *Conceptual features* are matters about the real world that are not definitely localized in reality, e.g. problems, projects, potentials, etc.

For PIS to deal with these elements without being overwhelmed by these spatial features, it should consider the graphical representation and the spatial reference of these objects. However, it is beyond the purpose of PIS to support spatial analysis and representation of maps. These tasks could be conducted using a standard GIS program if necessary. For PIS, it is important to facilitate interface with standard graphical formats to allow exchanging graphical data from other graphical and geographical programs.

b. Social Information entities:

A social entity in spatial planning is an actor that is involved, participating in, affects or affected by the planning process or the planning subject matter. A group of actors, that have something in common, represents a party. Parties are classified into organizations and groups. The formal status is the main difference between an organization and a group. An organization is a formal body while a group is an informal body. An example of a formal group is the members of a specific public organization while an interest group in the community subject to planning is an informal group. In addition, there are functional parties that are groups of individuals for functional purposes in the planning process e.g. mailing list.

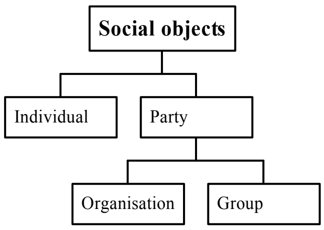


Fig. 3-5 The subject-matter domain > Empirical information > Social information objects

2. Analytical knowledge

In planning, it is not enough to describe the subject matter of planning. There is a need for knowledge about 'why this is, was or will be the case'. This type could be called 'analytical knowledge'. It takes the form '*x is y because of z*', '*x was y because of z*' or '*x will be y because of z*'. If a specific endeavor is solely concerned with analytical knowledge about spatial phenomenon, it is then considered as a branch of spatial analysis e.g. regional analysis, urban analysis, etc. For the same subject different analytical views could be available presenting different viewpoints or from different disciplines.

3.Normative knowledge

For planning to be needed, there should be a discrepancy between 'what is the case' and 'what should be the case'. Normally, planning will be needed when discrepancy is apparent or is expected to occur in the future. This type of knowledge is expressed in normative statements in the form '*x should be y*'. This type could be called normative knowledge. Rittel (1982) called this form of statements deontic knowledge. Deontic by definition includes obligation and necessity (The American Heritage Dictionary of the English Language). In most cases, principles and objectives of spatial planning are normative rather than obligatory.

Conclusion

The importance of distinguishing these three types of knowledge, i.e. empirical, analytical and normative, for developing planning information systems emerges from the fact that each type will have different requirements and life time. For example, most people will agree on 'what is the case' but few will agree on 'why this is the case' or 'what should be the case'. While it is possible to change the level of details or representation of 'what was or is the case', it is more possible that different viewpoints and positions will exist on 'why this is the case' or 'how it should be'. In other words, for a planning information system to deal with these differences, it should recognize the above-mentioned differences.

Information about the following categories of primary objects is normally included in most of these systems:

- Natural elements (e.g. river or mountain)
- Artificial elements (city, village, etc.)
- Virtual elements (borders, administrative subdivisions, etc.)

Most of these types are spatial in nature. For representing a spatial object, there is a need for both graphic representation and alphanumeric information. In addition, there are the interrelations among these objects. Describing and representing these interrelations are important aspects in PIS. In addition to these spatial categories, other important categories are crucial for exploring the subject matter, namely:

- Conceptual elements (potentials, problems, activities, projects limitations, restrictions, conflicts, etc.)
- Social elements (actors, interest groups, stockholders, etc.)

For these primary elements to be useful in exploring the subject matter of planning, different types of abstractions are needed. These abstractions represent the relations, the interdependencies, comparisons or key figures about the primary elements. Among these abstractions, the following two types are proved to have an important role in exploring planning matters:

- the spatial overview
- the chronological overview.

These two aspects are discussed in detail in section 4.2.

3.1.2. The planning-knowledge domain

Planning knowledge is all the knowledge that is needed in planning. It includes what planners learn including methods, theories, case studies, laws, etc. It is found in lectures, courses, professional periodicals, handbooks, manuals, conferences, seminars, etc. This knowledge is fragmented, growing, changing rapidly and is in different formats and standards. The tasks of a PIS, regarding information in this domain, include the following main tasks:

- to create networks of professionals and institutions dealing with similar problems for exchanging experience and solution ideas,
- to make this knowledge available for participants in the planning context and beyond in an easy manner, and
- to show where knowledge is missing and to promote producing it.

Normally this type of knowledge is related to a specific context, e.g. a country, a region, a specific type of planning problems. It includes mainly the following types of knowledge: formal, instrumental, case studies and Meta knowledge.

1. Formal knowledge

A legal framework governs spatial planning. It is difficult to think of a spatial development that could be undertaken outside this framework. This framework covers both the content of the planning as well as the formalities of planning. For planners in a specific context, the formal knowledge includes the following aspects:

- laws and regulations of different types that influence the planning for spatial development;
- formal plans, e.g. land use plans and zoning plans, that have normally the power of law and govern the development in a specific area;
- norms and standards e.g. the sizes of different types of streets, the ratios of green areas to the built up area, etc.

In addition to the spatial planning law, different laws about building, environment, traffic and transportation and public health are directly related to spatial planning. Some of these laws regulate the content of the development that could be conducted in a specific context while others regulate the process of planning itself including participating actors, planning procedure, public participation, objections, etc. These different types of formal knowledge should be available for participating actors in a specific planning process or generally, in a specific spatial context, that has the same legal or formal framework.

2. Instrumental knowledge

Instrumental knowledge is the knowledge about instruments and methods for problem solving or for conducting a specific task in a planning context. This type of knowledge is normally documented in guidelines, manuals, handbooks, textbooks, etc. It covers a wide range of aspect starting from information representation, analysis, prediction and plan making techniques, to how to use different computer applications used in this planning context. Planners normally have most of the knowledge they need in mind. However, it is impossible for any planner to have all the instrumental knowledge that he might need to conduct all the tasks that he might come across throughout his professional life. Some of these instruments are widely accepted and used; others are limited for specific application areas. Some of these instruments are changing with time while others are stable. Stable instrumental knowledge are normally a form of logical knowledge that includes pieces of knowledge that are proved using rules and laws of the used logic, e.g. algebra rules $(x + y)^2 = x^2 + 2xy + y^2$.

3. Case studies

In most problem solving situations decision makers and planners use their individual experience or group expertise in the form of implicit knowledge i.e. unspoken knowledge. They know it; they understand it and they use it. This type of knowledge is normally personal and is used for sense making, problem solving and gaining of perspective. This type of knowledge is also called tacit knowledge as it is usually personally held and rarely documented (Choo 1998). The task of case studies is, therefore, to convert this implicit knowledge to explicit knowledge in the form of written documentations that externalize personal knowledge for others. The subject of case studies in spatial planning is discussed in details in chapter 4.

4. The Meta knowledge

Meta-knowledge deals mainly with two types of information. First, it should answer the question where each piece of information or knowledge is found. The task of PIS regarding this type of knowledge is to support access to all types of knowledge using different contexts. Second, it will include notational knowledge that is concerned with what each piece of knowledge means.

3.1.3. The process domain

As mentioned earlier in any planning situation, different actors are attempting to solve the planning subject matter. For these actors to work together there is a process in which they organize their effort to reach their goal. This process could be a formal or informal process. Although in some cases, the participating actors in a planning process might be members of the same agency or organization, it is usual that the spatial planning problems require cooperation among different organizations and individuals. In any planning process different types of information, processes are embodied. These information processes include, but they are not limited to the following, organization, coordination, communication, decision-making, and documentation. Information in the domain could be then defined as any information that is processed, used, or generated in the planning process. The process domain usually utilizes information form both the subject-matter and the planning domains as the input for the process and then produces different types of output such as the results of planning, reports, publications, etc. In other words, information from the above-mentioned two domains are considered the input to the planning process, while information in the process domain could be considered the throughput of the planning process. The output from the process domain might represent a part of the subject matter or the planning knowledge domain. For the same subject matter, several process domains could exist simultaneously. This could occur if different teams deal with the same matter or different organizations deal with the same problem from different viewpoints.

The importance of information in this domain emerges from the huge amount and the variety of information that is circulated in this domain and consequently the overhead that is needed to deal with it. In many cases, it gets less attention compared to information in the other information domains. Different categories of participating actors have different roles and rights in this domain.

Information objects that are produced or processed in a specific planning process are typically internal information that are not related to the problem itself or to the specialized knowledge of planning in general. It is related to the planning process in the form of communication, organization and coordination matters.

The lifetime of information in the process domain is largely limited to the time-span of the process itself. However, this does not mean that information in this domain must be destroyed by the end of the process. The coverage of information in this domain is normally limited to the process itself. The main exceptions are the output of the process and the achieved information that might be kept for a specific time for documentation purposes. It is important to classify the different information objects that are processed in this domain. For this classification, different information processes are identified and analyzed:

- Organization
- Coordination
- Decision-making
- Communication
- Documentation

Each of these processes has specific characteristics and structure in general. However, each of these processes has specific characteristics in spatial planning. In the following sections, the general structure of each of these processes and its characteristics in spatial planning are discussed. Then main information objects and processes are studied to figure out how it should be considered in PIS.

3.1.4. Summary of the planning information domains

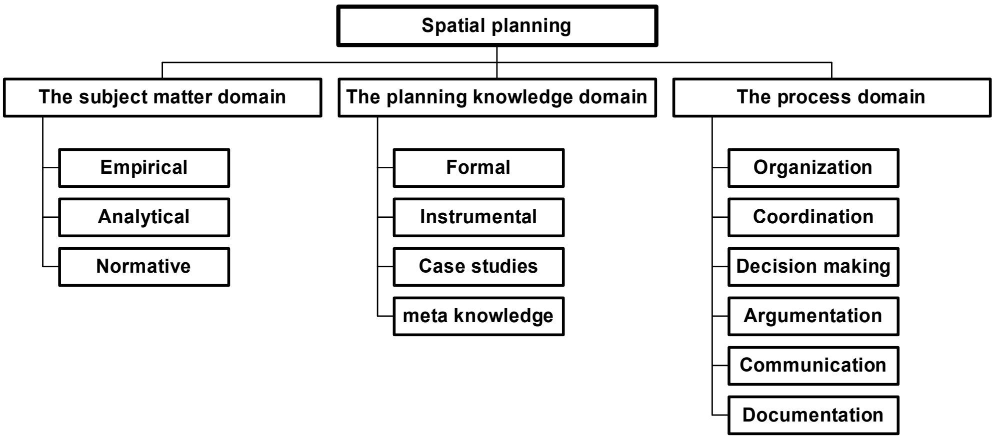


Fig. 3-6 Spatial information entities partition

In each of these domains and sub domains different types of information objects exist as shown in the following table:

Knowledge domain	**Types of knowledge**	**Information objects**	
The subject-matter domain	Empirical knowledge	Spatial	Natural elements (e.g. river or mountain) Artificial elements (city, village, etc.) Virtual elements (borders, administrative subdivisions, etc.) Conceptual: Potentials, problems, activities, projects limitations, restrictions, conflicts, etc.
		Social	Actors, interest groups, etc.
	Analytical knowledge	Why this is, was or will be the case.	
	Normative knowledge	What should be the case (Goals and objectives)	
The planning domain	Formal knowledge	Laws and regulations Formal plans Norms and standards	
	Instrumental knowledge	Guidelines, Manuals, Handbooks, Textbooks,	
	Case studies		
	Meta knowledge	Location: Where each piece of information or knowledge is found	
		Notational: What does each piece of knowledge mean	
The process domain	Organization	Task statement Participating actors Process organization Resources Time organization	
	Coordination	Actions Goals and objectives of different phases and steps Task assignment Interdependencies and relations	
	Decision making and argumentation	Idea, proposal, alternative, option and decision or plan and argumentation positions	
	Communication	Question / answer, request / replay, notes, announcement, preferences, message, discussion issue	
	Documentation	Documents, maps, links and media.	

3.2. Planning Information Processes

As mentioned earlier, different aspects of spatial planning processes could be considered as an information process in some way or another. In each of the above-mentioned domains of planning information, different information processes could be identified. Using the information process concept, each step in the planning process is based on information input from outside the process or from previous steps in the process. Each step or phase is considered an information processing. The results of the whole planning process could be considered as information output. Output from a planning process might represent an information input for other processes for example the implementation of the planning results.

An information process could be then defined as any process where information is processed, communicated or produced. Consequently, spatial planning could be understood as a process woven of different information processes.

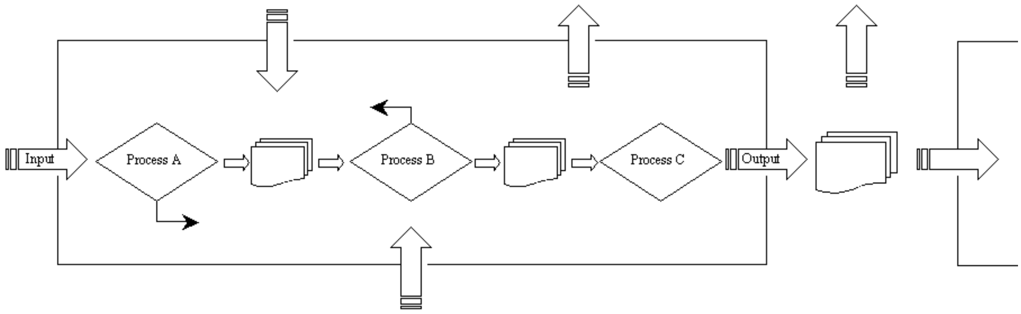


Fig. 3-7 Planning as information processing and production

Exploring the different types of information processes in spatial planning is aimed at finding out how PIS should support input, throughput and output of information that are needed, processed or produced in the different information processes in spatial planning. It is also important to consider the interconnectivity among these processes and how information resulting from a process is used as the input for other processes, or how the throughput of another process includes several processes of different types.

Information processes in spatial planning could be classified to different types regarding different criteria. Among the possible criteria of classification, the following are considered the most important for the development and the implementation of planning information systems:

- the goal of the information process,
- the nature of the information input,
- the expected information output, and
- the participating actors in the process.

In this section, the classification will be based on where a piece of information is produced or processed in the spatial planning. However, as mentioned earlier it is not possible or reasonable to use a general planning process for all situations and contexts. Therefore, this chapter concentrates on three information processes that are essential for any planning situation, namely: decision-making, coordination and communication. Further information processes are important in spatial planning and could be supported by PIS such as argumentation, documentation, public participation, etc.

This section is an attempt to explore the basic information processes in spatial planning. Among others, the following questions present key issues for this section:

- Where in the planning process is information processed or produced?
- Which information elements are used in each process?
- Where are the bottlenecks of information during the planning process?
- What are the main aspects that should be considered while developing PIS?

Aiming at identifying the fundamental elements that present the key components, in general, for each of these processes, this chapter starts with a brief theoretical introduction to the general principles that represents the base for exploring the main theories for each process. Then more emphasis will be given to finding out how each of these processes is embodied in the spatial planning process and what are the main characteristics of them. Exploring these information processes plays an important role in the identification of basic information elements, main information functions and main rules that are needed or shaped by each of these processes. This presents an important pre-requirement for the development and the implementation of PIS.

3.2.1. Decision-making

Decision-making in general

If an actor (person, group, agency or organization) selects one from two or more alternative actions, then he is considered to be deciding. A decision problem could be stated in the form of the following questions "Which option or alternative should be chosen?" (Maurer 1985). From this short definition of the verb "to decide" two main components of a decision problem could be distinguished, an actor and alternative courses of actions. Each of these alternative actions has uncertain outcomes that might be influenced by circumstances that we cannot control. Based on these aspects, the following questions are then essential for describing a decision problem:

- Who is the actor who should make the decision?
- What are the alternative decisions?
- What are the important circumstances that might affect the outcomes of this decision?
- What are the expected consequences of each alternative decision?
- What is the probability of each outcome that might result through a specific action and circumstances?
- What is the relative desirability of each result?

Decision trees are used to illustrate these components of a decision problem.

- There is an actor facing a 'decision node'.
- He should make a decision between two or more 'alternative actions'.
- Any alternative that would be chosen is subject to uncertain events called 'circumstances'. The actor cannot change these circumstances.
- Each of these uncertain events has a 'probability' to occur, which might lead to different' outcomes'.
- For the actor, each of these outcomes has a specific 'desirability'. Desirability ranges from much wished results to unacceptable.

Decision theory is concerned with how actors should weigh the known alternative actions, so as to maximize their expected utilities, regarding the probability of each alternative, and the expected outcomes of each alternative and its utility (Behn & Vaupel 1982).

For an actor facing a decision point, there is a basic decision to be made. He should choose amongst the following alternative actions:

- To do nothing;
- To wait and collect more information and attempt to clarify the decision problem if he can; or
- To select one of the known alternatives (Maurer 1985).

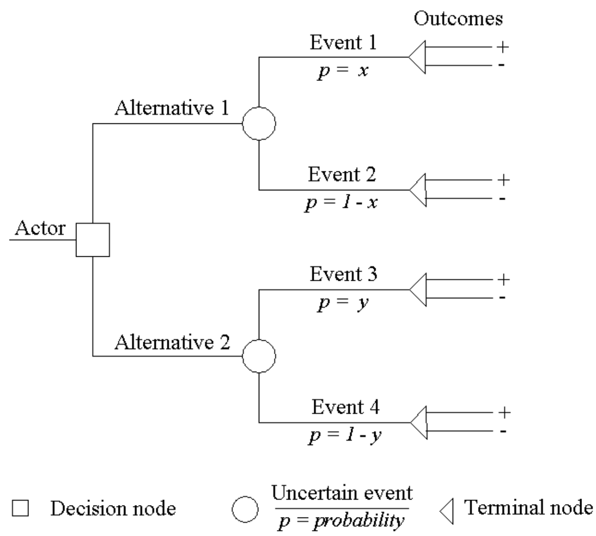


Fig. 3-8 Basic decision tree

This actor should then decide, taking into consideration, the expected outcomes, and the probabilities of the uncertain circumstances, which he cannot influence.

- If he decided to act, then he would probably achieve some desired utility. Meanwhile, he might fail and have to afford the cost of this failure.
- On the contrary, if he decided not to act, he might avoid this failure. Meanwhile, he might miss a desired utility.

If he decided to wait and clarify later, then he should keep in mind how long is the time window for this decision will be still open, and if he has enough resources to clarify the situation or not. Each decision situation has a specific time span in which making a decision is still possible. When this time is expired, the decision will have no effect. Meanwhile most real life decision situations are dynamic, waiting is associated with uncontrolled change in the probabilities and the circumstances.

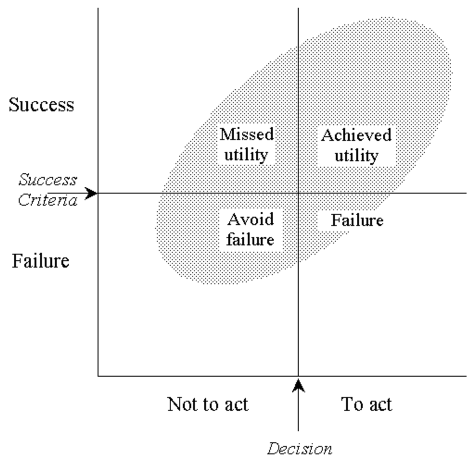


Fig. 3-9 four possible outcomes of a decision to act

Source: Schönwandt 1986

Fig. 3.9 illustrates a decision node where an actor should decide either ‘to act’ or ‘not to act’. It will be easy for this actor to decide, if the ellipse would be located to a large part on one side of the success criteria. If the large part of the ellipse is located above the success criteria line then it is easy to decide ‘to act’. Similarly, it will be easy to decide ‘not to act’ if the ellipse is located below the success criteria line. On the contrary, an actor will tend to wait and clarify if the ellipse would be equally located above and below the line. Regarding dynamics of the situation, it could be imagined that the ellipse is moving in an unsystematic way, simultaneously the success criteria line and the decision line are also moving.

Choosing between alternatives could be conscious or unconscious, rational or irrational. An actor is then described to be making a rational decision if he fulfils the following criteria (Maurer 1985):

- To describe the decision problem in a way that allows making a logical conclusion about the set of available alternative actions;
- To consider all available information and knowledge for clarifying the problem situation;
- To collect more information only when the benefits, in the form of an improved decision, is more than the cost, in the form of effort and delay of the decision;

For example, if an actor selected a specific alternative action by intuition or any other way, e.g. throwing a coin, then he would not be making a rational decision even if his choice led to the desired outcomes. In addition, he would not be making a rational decision, if he purposely ignored some of the available information and knowledge, or if he kept on collecting information that will not change his decision.

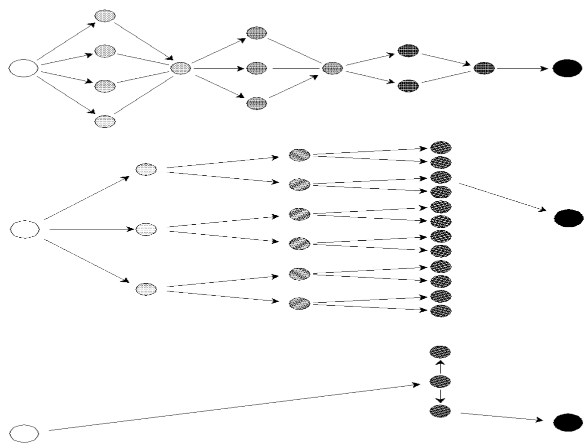


Fig. 3-10 Different ways to choose an alternative

Source: Pahl & Fricke 1993

Decision-making in spatial planning

In all the approaches to planning that were discussed earlier in chapter 2 as well as in any other approach or planning theory, there are always alternative courses of actions to achieve a goal or a desired state. The task of planning is to choose amongst these alternative actions. Different planning approaches have different methodologies in describing and solving the decision situation. However, it is impossible to think about planning, both spatial planning as well as any type of planning, without thinking of alternative courses of action to achieve this goal. This applies to all scales of decision situation from the small decision situations, such as choosing the road to work in the morning, to large decisions, such as allocating an atomic power plant or sending a manned spaceship to the moon. In other words, there is no planning without alternatives, i.e. if there are no alternatives, there will be no need to plan.

Dror (1973) defined planning as the process of preparing a set of decisions on future actions, directed towards the achievement of goals by preferred means. The basic decision problem in spatial planning could be formulated in the following terms: given limited resources (time, capacity, personnel, money, etc.), a variety of possibilities (alternative actions) and partial knowledge to choose the action with the highest probable future utility. This should be done under uncertain circumstances “exogenous factors” that could not be influenced (Maurer 1985). Decision making in spatial planning takes place in different situations starting from the decision ‘to plan’, or how the process should be organized. Different decision situations in the spatial planning will be briefly discussed hereafter.

a. "To plan" or "not to plan" this is the first decision

As mentioned earlier, 'to plan' is a cognitive activity and not per se. Then, in planning the primary decision is to decide about the action of planning itself. An actor (individual, agency, organization, etc.) faces a decision node by recognizing that the outcomes of the "is-state" are not desired. For example, the living conditions in the city are deteriorated or will deteriorate, the environmental pollution has reached critical levels or the urban growth is increasing over the green areas outside the city. In addition, this actor will be facing a decision node by recognizing that the probable utility of the "should-state" is more than the expected effort to achieve it. For example, the establishment of a new city will create residential units and job opportunities, which would bring more utility than the costs needed for achieving it. Consequently, he should choose among at least three basic alternatives:

- 'To plan',
- 'Not to plan' or
- 'To wait, to clarify and to decide later'.

Generally, all the following cases are decisions from the viewpoint of decision logic:

- To decide 'not to decide at all' is a decision;
- To decide 'not to decide now, to wait, to do nothing now and to decide later' is a decision;
- To decide 'to collect more information, to clarify and to decide later' is a decision;
- To decide 'to do nothing at all' is a decision.

b. Decisions regarding the planning process: 'How to plan?'

If the above-mentioned actor has decided to plan, then he has to make another decision about the planning process. Facing the decision point about how the planning process should be organized, amongst the different alternative courses of actions, the following are some examples that this actor can choose from:

- to plan by himself or in his agency,
- to give the job to another agency or organization, or
- to organize a planning competition.

Although this issue might seem to be a matter of organization, it is a clear decision situation. An actor has to choose among different alternative actions. Each of these alternatives has different probable outcomes. Some of them are positive and some are negative. Meanwhile, there are uncertainties that could influence the results of his decision. Each aspect of organizing the planning process could be stated in the form of a decision problem. For example, regarding the multidimensional and interconnectivity in spatial planning, the number of participating actors in the spatial scene could be very large. It is then important to decide which actors should participate, who is the actor that should make a specific decision and who are the actors that could influence the circumstances or might be affected by the decision outcomes.

c. Decisions about the subject matter of planning: 'What to plan?'

Another aspect of spatial planning is the preparation of decisions over localization of spatial activities as well as their meaningful mutual allocation to each other (Krause 1998). Regarding the spatial subject of planning, there are alternative solutions for each problem. A planner or a group of planners should select amongst these alternatives. By this decision, there would be an embedded decision about who would get the benefits and who would bear the costs of planning decisions, or how a compromise between conflicting interests would be achieved (Batley 1993). In this sense, spatial planning could not be conceived only as the identification of problems and their resolutions but also as a process of balancing conflicting claims on scarce resources as well (Cullingworth 1973).

d. Decisions about information in spatial planning

It is widely accepted among planners and decision makers that the ability to make appropriate decisions depends, amongst other things, on the availability of information (Devas & Rakodi 1993). This involves the following types of information:

- Information about what exists and what is going on in the world,
- What may be expected under certain specified conditions, i.e. the relations between circumstances and the wished results.
- What may happen if a specific alternative action is chosen, i.e. relations between the actions and consequences of these actions,

Facing a decision situation, there are three main tasks, namely thinking, gathering and processing information. Behn and Vaupel (1982) argue that most people devote 99 percent of their decision-making time to gathering and processing information. This task takes different forms, e.g. talking to people about the problem, reading relevant material, developing complex models or theories, or carrying out elaborate chains of calculations. However, it is clear that gaining a full knowledge of any human situation or social system is an immense task (Bracken 1981). A more commonly accepted notation is rationality of decision making as mentioned earlier. Any actor in a decision situation is faced by the opportunity to collect more information before making the decision, i.e. the third basic alternative at any decision node "wait, clarify and decide later".

The situations for an actor facing the opportunity to collect more information could be described as a decision situation. In such a situation, an actor has different alternatives regarding collecting the information, namely "to collect it" or "not to collect it". This situation is combined with different circumstances and different positive and negative outcomes, e.g. clarity, uncertainty, cost, effort, etc. It usually makes sense to obtain information that could be obtained with no or very low cost, before choosing an alternative action. However, if by obtaining this information, the chosen alternative action will not be changed anyway, then, there is no reason to exert any effort in obtaining it. On the contrary, if this information will make the decision obvious by improving the decision maker's capacity to make a better decision, either by decreasing the uncertainty about future events or by changing the probabilities of the outcomes, then he should collect this information. However, he should balance between the cost of this information in the form of money, effort and time on one hand, and the gained benefit on the other. The information would be perfect if it eliminated all uncertainty and allowed a faultless prediction of the future (Behn & Vaupel 1982), i.e. in Fig. 3.9 the ellipse will either move completely to the upper right corner or to the lower left corner. In such a situation, the actor would be completely sure about the outcomes of his action. This situation is rare, if not imaginary, in spatial planning.

Characteristics of decision-making in spatial planning

a. Networked & Interconnected

Taking in consideration the above-mentioned three aspects of decision-making in spatial planning, it is argued here, that spatial planning could not be described as a single branch of a tree. It is a more complex tree of sequences of decisions as shown in Fig. 3.11.

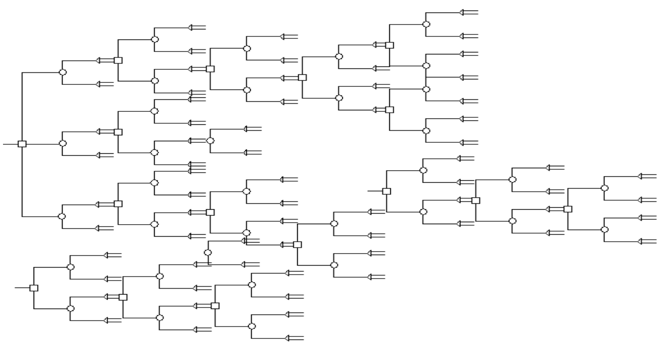


Fig. 3-11 Decision tree in a planning situation

Furthermore, by nature, spatial planning is not dealing with individual self-contained problems, but it is dealing with a network of interconnected decision problems. It is seldom in spatial planning that a problem and the decisions about it are not related to any other problem or decision (Maurer 1985). In many cases, the outcomes of a specific decision represent a decision node for another actor or a circumstance for another decision problem.

b. The time lag between decisions and outcomes

The impacts of spatial activities could only be noticed on the long-term. The time between identifying a problem, making a decision, implementing this decision and realizing the outcomes of the selected action is a long time. Sometimes this time could be decades e.g. a decision about building new cities. This time could be called the time lag. During this time, the actor might have no influence on the actions he had selected, unless he has considered this in his decision. He has also no influence on the circumstances that might affect the outcomes of his action.

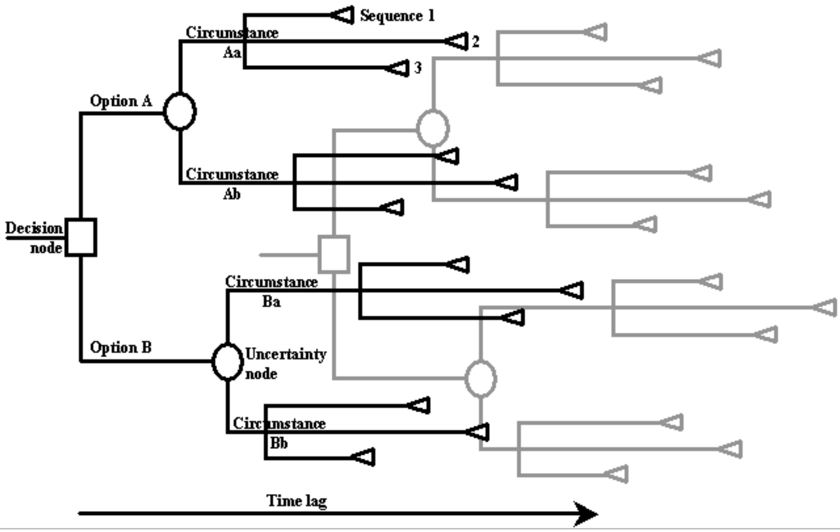


Fig. 3-12 The time lag between actions and outcomes.

Source: Scholl 1995

c. Long-term and side effects of actions

Most spatial activities have long- and side effects. Long effects result from the dynamism of the spatial context and the changing social, technical, political and environmental factors that were not considered during the decision making process. Side effects result from the interconnectivity between the decision problem subject and other subjects that were not clear or were ignored during the decision making process. The possibility to change these effects is limited. This issue was discussed in details in an earlier section.

d. Success criteria of decisions

It is simple to compare the outcomes of decisions objectively if they could be described in the same unit e.g. money. However, in complex situations such as spatial planning, different actors are participating in the decision-making and different parties would be affected by the outcomes of the selected course of action. In such situations, different actors would have different preconceived success criteria that are directly related to the actor's interest and background. In the afore-mentioned example of the high-speed railway line in Switzerland, the outcomes of any decision could be compared using different criteria such as travel time, noise, capacity, connectivity, and the image of the landscape. For the railway corporation, the project would be considered a success, if the travel time was optimized and the line capacity was maximized. Meanwhile, for a group of environment activists, the same solution might be considered a disaster as it devastates a sensitive landscape. They might consider it as a success if the track is changed to bypass the sensitive landscape, leading to increasing the travel time. This pair of conflicting success criteria is a result of the different domains of observation. A second dimension could be identified if we compared the position of a regional official with the position of the residents of a village where the line is expected to go through or around their village. For the regional official, the project would be observed as a success if his region got a direct connection, which increases the accessibility of his region and hence its attractiveness for investments. On the contrary, the residents of the village would consider it as a failure as they would have to bear its negative impacts without any gain. This dimension is a result of the different levels of observation. The same decision would be also observed differently regarding the other dimensions of spatial planning that were mentioned earlier namely the inter actor and the inter region dimensions. Therefore, it is apparent that success of spatial planning decisions could not be measured against a mono dimensional success criterion that considers only the interests of one actor in any of the above-mentioned dimensions.

PIS and decision making in spatial planning

From the above-mentioned aspects of decision making, in general, and in spatial planning in particular, a PIS will inherit the different aspects of decision-making.

a. A primary set of decisions regarding the PIS would be needed as follows:

- A decision about the need for a PIS, to decide to develop a PIS;
- Decision about participation: who should participate?
- Decision about information: which types of information should be included?
- Decision about the technical issues: which techniques should be applied?

b. The second dimension is related to supporting decision making in planning by supporting exploring different alternative courses of actions, the expected outcomes of these actions and the circumstances. PIS should make this information accessible for the participating actors.

c. Dealing with the above-mentioned characteristics of decision making in spatial planning argumentation among participating actors and with other parties is essential. The PIS should support this argumentation be facilitating the following aspects:

- To explore the barely tangible mass of information that is widely undetermined (subjective and objective),
- To sketch, to describe and to analyze sequence of decision problems, and
- To define and to explain decisions (Maurer 1988).

Furthermore, PIS should also support exploring decision situations of spatial planning in the different domains and levels that are related to the decision situation.

3.2.2. Coordination

The simplest definition of coordination is “the act of working together harmoniously”. However, coordination theory defined coordination as "managing dependencies between activities performed to achieve a goal" (Malone & Crowston 1990). Coordination theory concentrates on some basic aspects of coordination processes, namely goals, actions, actors, and interdependencies. There must be one or more actors, performing some activities, which are directed towards some ends or goals. The goal-relevant relationships between the activities are interdependencies. (Malone & Crowston 1990).

For coordination to take place there must be some form of organization in the background. Organization in the simplest definition is answering questions such as: what, how, who, where, when and why? Organizational information in the planning process might include information objects about the following subjects:

- What is the task of the process? What are the goals and the expected outcomes?
- Who are the participating actors? In most planning situations there are more than one actor. Planning processes normally include different institutions and individuals. This might include private, public and NGOs. Different actors in a process have different roles. There are the roles of the city administration, the legislative institutions in the area, the interest groups and other actors that might affect or be affected by the planning, etc.
- How the process of undertaking this task will be organized? Is it a formal process? Is it governed by clear rules? Is it an informal process?
- Which resources are available for this process? Resources include personnel, time, finance and capacity.
- How the process will be organized over time? Is it a formal process with specific time organization? What are the main milestones that should be considered in the process?
- Concerning internal work organization, what are the main phases of the process? This information is represented in the process time line. Different events are presented in the process calendar.

Coordination in spatial planning

Milliken (1997) argues that design and planning are social processes between individuals who often come from disparate professional backgrounds. These processes are inherently collaborative processes, hence, requiring the negotiation and the reconciliation of different views, perspectives, vocabularies and knowledge bases associated with a problem-solving situation. Consequently, coordination in spatial planning deals with some essential aspects that are concerned with some basic questions as follows:

- *Goals*: identification of the overall goal. How to coordinate goals among the different actors participating in an activity. Definition of goals of a planning process is a matter of discussion, coordination and cooperation rather than a closed or one-actor task.
- *Actions*: decomposition of overall goals to activities. How can overall goals be subdivided into actions?
- *Actors*: which actors will participate and how the tasks will be assigned. Witnessing the withdrawal of official dominance of activities to private and non-governmental sector,

participating actors in spatial planning could be grouped into formal and informal actors. Laws related to spatial planning define formal actors. They are distributed on different levels: national, regional, and communal levels. Moreover, they are from different disciplines. In addition, there are the informal actors, who participate indirectly or have no formal role, e.g. individuals, interest groups, political parties, academic and research centers. Informal actors have a changing role in spatial planning that affects the planning and decision-making process.

- *Task assignment*: How actions are assigned to groups or individual actors?
- *Interdependencies*: How to manage interdependencies? If there are no interdependencies, there is no coordination. Interdependence between activities can be analyzed in terms of common objects that constrain how each activity is performed. Interdependencies between actions include prerequisite, shared resources and simultaneity, etc. How can resources be allocated among different actors? (Malone & Crowston 1990).

Types of coordination in spatial planning

If we applied the above-discussed concept of coordination to spatial planning, three major types of coordination could be distinguished:

a. Coordination of activities that have spatial impact

Although Maurer (1985) was describing the Swiss guidance-planning (Richtplanung) from a legislative viewpoint when he stated that one of the main tasks of spatial planning is coordinating activities with spatial impacts, it could be argued here that this could be applied to all planning activities with spatial impact anywhere and on any level. Coordinating activities that have spatial impacts is a continuous process that starts by finding out which activities hinder, conflict with, delays, are essential for, or complementary to others. However, coordination between different actors should concentrate on their spatial activities and not on wishes, hopes or expectations (Maurer 1985).

b. Coordination of the planning process itself:

Planning processes consist of a large number of sub-processes that are carried out, influenced, affect or affected by autonomous actors (Stanoevska, et al. 1998). These actors normally are located either in different organizations or in different interrelated organizational units in the same organization. In public agencies, there is a tendency to isolation. This could result in the increase of the so-called executive blindness and territorial domination, which lead tendency to concentrate on the urgent actions and on the direct narrow scope of interest (Maurer 1988). However in planning processes, these actors have to overcome their immediate actions and their narrow area of interest, they have to deal with common tasks and shared resources. Therefore, they have first to coordinate the coordination process itself (Maurer 1985).

c. Coordination of Information

For different actors or agencies to coordinate their spatial activities (decisions and actions) or to coordinate the planning process, they have to coordinate their information and knowledge. What an actor is doing or planning to do, may affect the decisions of another actor. What an actor knows or thinks about, may affect another's decision.

This information or knowledge is not limited to the traditionally used quantitative information in planning but it includes related qualitative information such as: decisions, intentions, arguments, additional explanation, description of ideas, etc. An extended discussion of this subject will be introduced in a following chapter.

Dimensions of coordination in spatial planning

Two main dimensions of coordination in spatial planning could be distinguished, namely: horizontal and vertical (Hahn 1999). Horizontal coordination takes place among different actors, sectors and disciplines in the same region in order to negotiate and integrate domain specific plans into an overall strategy. It also takes place among different interdependent regions, so that their different local views could be brought together in a common view if they are compatible or to be redefined, if they are conflicting. Horizontal coordination takes place on inter-communal, interregional or international levels. Vertical coordination takes place among different levels of spatial units, e.g. national and regional or regional and local. Each of these dimensions of coordination could take a positive or a negative form. Horizontal coordination takes the positive form when different units of the same level of planning or different actors in the same planning unit cooperate. This coordination could occur by formulating common goals or by applying conflict resolution processes that go beyond formalities. On the contrary, negative form of horizontal coordination takes place when one actor or more has/have a bad reputation regarding cooperation or by the tendency to enforce his/their own interest over others.

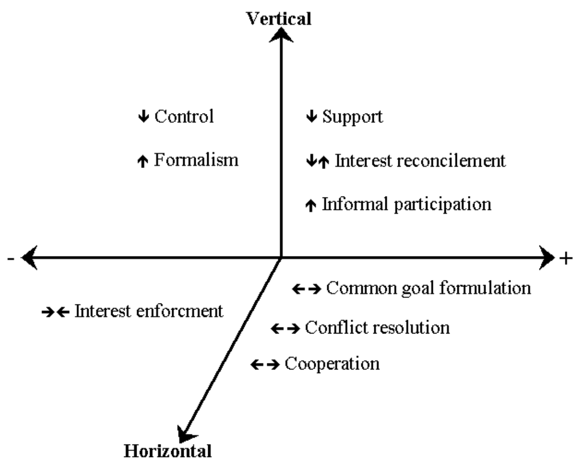


Fig. 3-13 Dimensions of coordination in spatial planning

On the other hand, vertical coordination takes the negative form when the higher units attempt to control the lower ones and figure out if they have fulfilled the guidelines for spatial planning or if these guidelines are properly respected. Vertical coordination also takes the negative form, if the sole aim of lower units will fulfill formalities stated be laws and regulations 'Formalism'. On the contrary, positive form of vertical coordination takes place when higher levels support lower units by financing development programs or through capacity building for lower units then the vertical coordination is not a zero sum for the lower units. It also happens when the interest reconcilement takes place among different levels of planning. This reconcilement might sometimes require informal participation that is not limited to the formalities. Communication under these circumstances is difficult because of the long-term process; the wide rang impacts of spatial activities, the number of participants and the different sources of information.

Characteristics of coordination in spatial planning

a. Complexity:

The first task of coordination in spatial planning is to define what should be coordinated. This coordination takes place under the following circumstances:

- The number of spatial activities in a region is normally large. In addition, there is a multi-dimensional interconnectivity amongst these activities as well as with other spatial aspects. This means that different urban development activities, potentials and problems are interacting in the region simultaneously. Among these aspects, some might be disturbing, interfering, connected, complementary, or prerequisite for another activity. In addition, the ownership or the responsibility is spread among different authorities and actors because of the interdisciplinary nature of spatial planning.
- On the process level, the number of actors that might take part in a complex planning process is large. Scholl (1995) argues that this number ranges from 30 to 50 actors. Furthermore, these actors have differentiated roles and they are spread in different public and private agencies.
- Regarding information, the amount of information is huge. Including objective and subjective information, it takes different forms and formats. Its accuracy is limited and its content changes.

b. Span and depth:

In spatial planning as a continuous process, coordination starts by the foresight before starting the planning itself and continuous throughout the process until the implementation. For this continuity of the planning process, the plan should be dynamic. The depth and the accuracy of the statements should be actualized continuously. In addition, the unsolved problems, the open questions and the conflicts should be actualized as they define the future tasks for the planning (Maurer 1988).

For planning as a continuous process, it is important to allow concerned public institutions from different levels to check the planning in periodical systematic manner, and to express their views regarding the necessity of coordinating a specific topic and the needed coordination (Maurer 1988).

In attempting to design the coordination process in a planning situation, the accuracy and the level of details in the process are based on the problem situation. Hence, it could not be anticipated in advance, as it is not possible to use the same coordination process for all planning situations. The context must be considered and suitable processes should be organized.

The two extremes of coordination are to coordinate everything or to coordinate nothing. It is important to emphasize that who attempts to coordinate everything, coordinates nothing. On the contrary, ignoring coordination completely looking for the freedom and the dynamism will result in Chaos. Freedom and dynamism require order. The failure of order (the Chaos) is the highest grade of the loss of freedom (Maurer 1985). The need for coordination in this situation depends on the type and intensity of relations among the different decision problems.

c. Coordination and other information processes in spatial planning:

All coordination processes require that some decision should be made and accepted by a group of two or more individual actors or organizations. In other words, coordination starts by a group-decision to coordinate. Then to coordinate between two or more actors, they have to communicate. That means when a group starts to coordinate, the members of this group start to communicate, they share decisions, they organize interdependencies and they share information. On the other hand, it is important to distinguish the difference between coordination and cooperation. Coordination takes place between interdependent actors in the same sphere (Selle 1997), i.e. interdependencies exist among them. On the other hand, cooperation takes place among actors from different spheres, i.e. no direct or clear interdependencies exist among them (George & Jones, 1999).

PIS and coordination in spatial planning

Coordination in spatial planning could be classified into coordination of spatial activities, coordination in planning processes and coordination of information.

As far as the development of PIS is concerned, the following aspects are important:

- How can the application of PIS support coordination on the afore-mentioned three dimensions of coordination?
- What are the main coordination activities that should be supported?
- On the spatial activities' domain, PIS could support the coordination by illustrating the interdependencies among different activities and aspects on the spatial scene, by establishing an overview about these aspects, keeping this overview up-to-date and available for the concerned actors. This might facilitate the early identification of conflicting interests and

expected problems. This overview should consider the different domains of observation that were mentioned earlier. It should also consider the specific characteristics of coordination in general, and coordination in spatial planning in particular.

- On the process domain, coordination throughout the planning process often takes place without special arrangements. However, for the development of planning information systems, analyzing these processes is essential. It will be then possible to identify for which process the application of PIS is needed. Then for these coordination activities to be implemented, it would be important to categorize the actors who should participate in the coordination, the goal and objectives of coordination, the tasks that should be conducted to achieve these goals, the time plans, the interdependencies among these tasks and activities, etc.
- On the information domain, it should consider the coordination of information elements. This coordination includes the definition of the interdependencies among these information elements as well as their interdependencies with information elements in other information domains. The second aspect of information coordination is the coordination of responsibilities among the participating actors.

In addition, there is the coordination of the content of this information on the Meta level in the form of a common language. This subject will be discussed in more details in the coming chapter.

3.2.3. Communication

Communication in General

Communication is one of the most important processes that take place in organizations; it has major effects on individual, group and organizational performance (George & Jones 1999). However, communication has different perceptions considering the position of the observer. On one hand, Claude Shannon in his work "*A mathematical theory of communication*" (1948) interpreted communication as the transmission and reception of information. According to this point of view, the main concern of communication is the reproduction of a message to one point either exactly or approximately as the message is sent from another point. Semantic or logic issues of communication are not a matter of interest. On the other hand, A. Richards from a humanistic perspective interpreted communication as the generation of meaning (Griffin 1997).

Other definitions attempted to overcome these conflicting views, e.g. Friedman and Keeps defined communication as "the management of messages for the purpose of creating meaning" (Griffin 1997), or "the sharing of information between two or more individuals or groups to reach a common understanding."(George & Jones 1999). Consequently, communication takes place when a cognitively meaningful signal or message that is involving some knowledge is transmitted between two or more things in some natural or social environment. As the simple sharing of information is not enough for communication to occur, reaching a common understanding is considered an essential defining feature of communication. In other words, communication takes place by sharing of information to reach a mutual knowledge between two or more actors. However, reaching a common understanding does not mean that people have to agree with each other, but they must have a relatively accurate idea of what a person or group is trying to tell them (George & Jones 1999). The lack of this common understanding reduces the effectiveness of the group's performance as well as the efficiency of its members.

Components of the communication process

George and Jones (1999) argue that communication processes include the following distinct components (Fig. 3.14):

- Sender: The individual, the group, or the organization that needs or wants to share information with another individual, group, or organization;
- Receiver: The individual, the group, or the organization for which the information is intended;
- Message: The messages that a sender needs or wants to share with others. Communicated messages could be visual, acoustic, electromagnetic, chemical, etc. Verbal communication takes places when sharing information occurs through words, either spoken or written;
- Medium: the pathway through which an encoded message is transmitted to a receiver;
- Language: that facilitates both encoding, i.e. translating a message into symbols that a receiver can understand, and decoding, i.e. interpreting or trying to make sense of a sender's message.

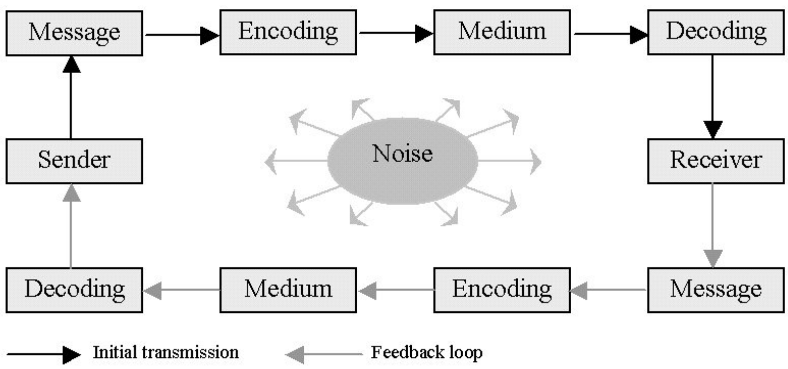


Fig. 3-14 Components of communications process

Source: George & Jones 1999

When two or more things communicate, either in only one direction or in both directions, they comprise a communication system. However, transmission of messages in such systems is subjected to distortions due to uncontrolled random changes in the communication channel (Bunge 1999).

In general, four main functions of communication could be distinguished as follows (George and Jones 1999):

- Providing knowledge: a basic function of communication is to provide knowledge to the members of an organization so that they can perform their jobs effectively and achieve their goals. By providing knowledge about, for example, ways to perform tasks and about decisions that have been made, an organization makes sure that its members have the information they need to perform at a high level of work. By mastering communication in organizations, members of these organizations have the information they need when they need it to achieve their goals. (George & Jones, 1999)

- Controlling and coordinating individual efforts: to manage interdependencies among the members of the group, to eliminate duplication and to prevent one poorly performing member from hindering other members from achieving the group's goals.
- Motivating organizational members.
- Expressing feelings and emotions.

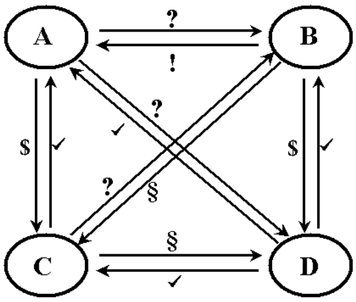
Communication in spatial planning

Regarding planning as decision-making or as coordination of spatial activities, it is essential that participants in the process should communicate in some form. Therefore, in a spatial planning situation, there will be a continuous communicative process involving these actors e.g. planners, decision makers, developers, the public, interest groups, etc. In a hypothetical planning situation, where in all the afore-mentioned dimensions of the planning process only four actors would be involved in the planning process as following:

- Actor A is a regional planning organization that is conducting a regional planning process
- Actor B is a higher level planning agency, e.g. national planning authority;
- Actor C is a neighboring region that might be affected by the planning outcomes and
- Actor D is a local agency, e.g. transportation planning agency.

In the best scenario for this simplified communication process (fig. 3.15), assuming that each of these actors knows which information is needed, where this information is available and which process is needed to obtain it, clearly, the volume of information communicated among these actors might be extremely large.

However, in a real planning situation, the number of involved actors, both directly and indirectly, would be relatively large. As mentioned earlier, it is likely in a complex planning situation that up to 50 actors may participate in the process (Scholl 1995). Taking into consideration the complex nature of spatial planning, these actors - public agencies and private actor - would have different roles, different or conflicting- interests, various information policies and different priority (fig. 3.16).



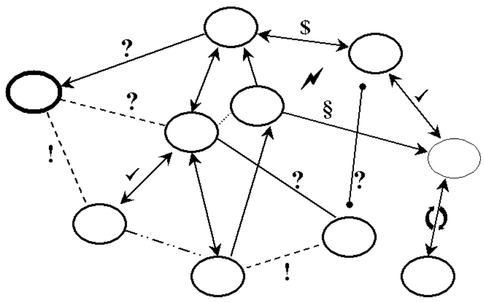


Fig. 3-15 Communication in a simple planning situation	Fig. 3-16 Communication in a complex planning situation
Modified after Elgendy 2000	Combined and modified after Stein 1994 & Elgendy 2000

In this situation, many uncertainties exist regarding the creditability of the communication process on all the three domains discussed above. Would each actor communicate with all other actors to check their activities and their future plans regarding the region? If this would happen, we should think about how much information would be circulated and how many resources each actor would devote to gathering and organizing this information. What will be the situation if an actor ignored communication with another actor that might be affected by his spatial plans? This might happen if the communication might affect his interests negatively.

These communication processes could be assigned to the three domains of information that were discussed as following:

- Communication about the subject-matter of planning includes aspects:
  - Counseling about the identified problems or conflicts,
  - Communication with other actors to coordinate actions or to request information,
  - Reporting relevant events, offering opinions and advice (Foster 1985),
  - Negotiations with potential investors,
- Communication about the planning process such as:
  - Communication of work plans and other organizational messages,
  - Suggesting proposals to solve the problem or resolve the conflict,
  - Arguing for or against particular proposals,
- Communication of information and knowledge is concerned with:
  - Communication of knowledge from similar cases,
  - Communicating policy and plan action to the public,

These classes of communication processes in spatial planning are not sharply defined from one another. They could be differentiated according to the basic characteristics of the communication process, such as: the sources and the target of the communicated message, the number of actors who participate in this communication and the type of the target group to whom the communicated message is aimed. Some aspects that are important for the development of PIS are discussed in the following paragraphs briefly.

a. External and internal communication

Communication processes in spatial planning could be classified according to the position of both the sender and the receiver of the message in the planning process domain. The importance of this classification emerges from the different requirements that each type requires. Two main classes could be identified, internal and external communication.

Internal communication occurs amongst actors inside the process domain. In other words, if both the sender and the receiver are participating actors in the process, then the communication is considered as internal communication. However, internal communication is not related to the spatial locations of the communicating actors. External communication takes place when an actor from one domain attempts to communicate with another actor in a different domain.

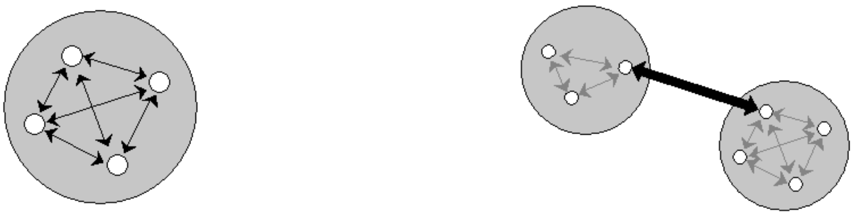


Fig. 3-17 Internal and external communication

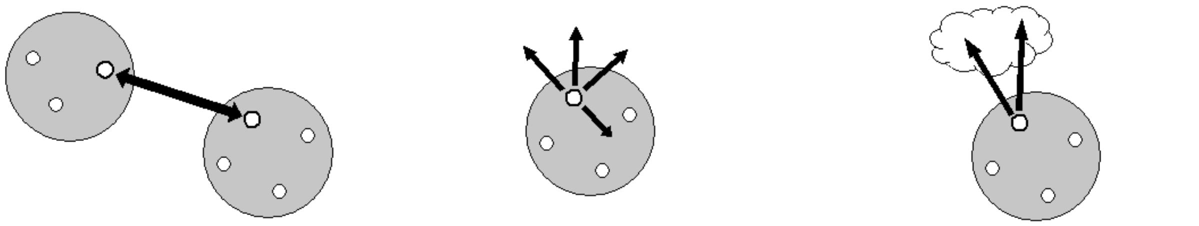
b. Extrovert and Introvert communication

In addition, communication processes could be classified according to the direction of the message. If the message is outgoing, this communication is extrovert. If the message is incoming the communication is introvert. This classification could be applied on both the actor level as well as on the whole process domain level.

Fig. 3-18 Extrovert and Introvert communication

c. One to one and one-to-many

If the communicated message is addressed to a specific receiver, then the communication is considered a one-to-one communication. On the contrary, if the message is sent without a specific intended receiver, then the communication is considered a nonselective one-to-many communication. In between these two cases, there is the focused one-to-many communication where the communicated message is aimed to a target group, which is not definitely known but identified by its characteristics.



One to one communication	Nonselective one-to-many communication	Focused one-to-many communication

Fig. 3-19 one-to-one and one-to-many communication

d. Formal & Informal communication

In traditional planning, communication is closely connected to the planning process that belongs to the responsibilities of individual organizational units in public administrations. In this type of communication, it could be said that it follows the course of files that moves from one person to another to fulfill the formal requirements. Selle (1997) described this process as "corridor communication" where each participating actor reviews the subject matter of communication consecutively. This process is structure-oriented and process-oriented. It is characterized by reducing the content of the subject matter to fulfill formalities that are specified by the laws and the regulations. This could be described as 'Formalism' of communication, which is time consuming and leads in many cases to solutions that are the mere accumulation of the results of the process steps, which in many cases has no effect in the reality.

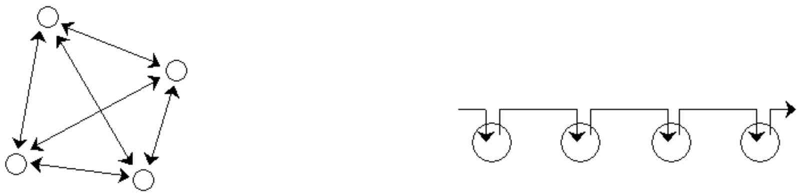


Fig. 3-20 problem-orientated and process -orientated communication

This type of communication is usually not effective when the problem is cross border of administrative subdivisions or on the city level when a private investor practices pressures to realize his development at a faster pace other than that used in public administration. In this case, public administration is forced to focus communication process in a more effective way, e.g. in round table meetings, where the most important actors can communicate directly in a focused manner with more problem solving orientation rather than with process-orientation. Also in blockade situations where conflicting interests or viewpoints exist, traditional and formal communication processes do not lead to solving the problem. In such situations, innovative and appropriate communication processes should be implemented. This problem-orientated communication is not easy for public administration as it confronts its routines and puts its formal processes into discussion (Selle 1997).

d. Communication and language

In each of these categories, communication requires that communicated messages should be transmitted in a language that is understandable to the group's members (Malone & Crowston 1990). The language used in communication is a decisive factor on the quality and the result of communication. George & Jones (1999) stated that communication is effective when members of the communicating group or organization share information with each other and all parties involved have a relatively clear understanding about what this information means. Communication is inefficient when people are not quite sure what the information they do receive means. Maurer (1985) argues that the limit of common understanding among members of a group is the limit of their common language. Establishment of this language depends on the ability of the actors to identify the common objects and interdependencies among them. This language includes common objects in all of the subject matter of planning, the process and the information domains.

e. Public participation and information

Planning from the top becomes less popular as nobody wants to be ignored while others plan at him (Rittel 1982). Public participation is stated in planning laws in different planning cultures. For example In the Swiss law for spatial planning (RPG Art. 4, Abs.1), it was declared that the public should be informed about the targets and the course of planning. Similarly, Märker and Pipek (2000) stated that in Germany whenever a planning process is conducted, some sort of public participation is obligatory by virtue of the law. This is valid regardless of whether it is concerned with building a new street or a railway, or planning a new industrial or commercial area. The applied planning procedures should assure that the public interests of the local community are not violated. Those planning procedures include different participation opportunities for citizens. For example, construction plans of a specific land parcel (Bebauungsplan) have to be made publicly available for a specific period. In addition, it should be explained in a way that makes it clear for normal citizens. Furthermore, local authorities should invite those who might be affected by the planned activities as well as related stakeholder organizations. During these participation measures, there have to be opportunities to influence the decision through written objections or at hearing sessions as prescribed by the federal laws. The responsible authorities should consider the results of the participation procedures during the decision making process for the project.

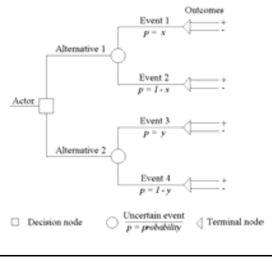
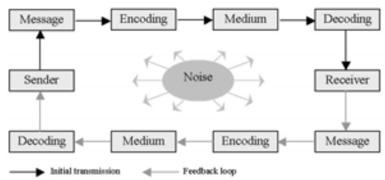
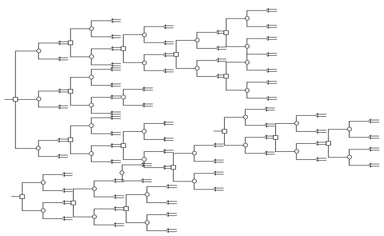
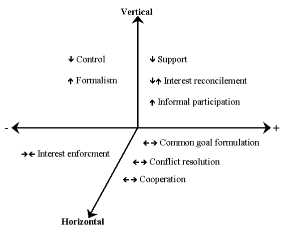
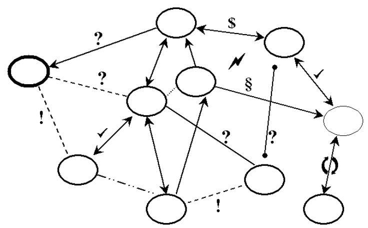
However, the fundamental aspects of such participation processes were criticized for several reasons. First, the claim of availability of the plans in the city hall for discussion is questionable. This offer was criticized as being only selective, as only some groups of individuals will benefit from it. Even if the public administration makes an invitation, this invitation process could sometimes be selective. Second, the comprehensiveness of the supplied explanations is usually questionable. Due to these factors, the level of participation in such processes is usually quite low (Märker & Pipek 2000).

While public participation is a formal requirement, public information could be used to clarify that a specific behavior is better or reasonable than others, for example using public transport instead of private cars as a part of traffic planning (Schönwandt 1999).

PIS and communication in spatial planning

- PIS could be used to support different types of communication in spatial planning in the subject-matter domain, in the process domain and in the information domain.
- Implementation of PIS should support innovative ways of communication that facilitate problem solving beyond the formal process-oriented communication.
- During the development and implementation of PIS, the differentiation between internal and external communication is essential. In addition it should support both introvert and extrovert communications.
- The differences between focused and nonselective communication is also important to be considered in PIS.
- For communication to be efficient using PIS the afore-mentioned common language among participating actors is essential.

3.2.4. Summery of decision-making, coordination and communication

	Decision-making	Coordination	Communication
Definition	Weighing the known alternative actions, to maximize their maximal expected utilities, regarding the probability of each alternative, and the expected outcomes of each alternative and its utility.	Managing dependencies between activities performed to achieve a goal.	Sharing information between two or more individuals or groups to reach a common understanding.
Process			
Components	▪ Actor ▪ Alternative actions ▪ Circumstances (have probability) ▪ Outcomes (have desirability)	▪ Goals ▪ Actions ▪ Actors ▪ Task assignment ▪ Interdependencies	▪ Sender ▪ Receiver ▪ Message ▪ Medium ▪ Language (encoding and decoding)
In spatial planning			

3.3. Planning information objects

The abstraction that could be applied using Ontology is needed for the highest level of typology or the conceptualization level. The procedural approach is essential to describe different information processes in spatial planning. However, on attempting to describe more detailed levels, the need for a less abstract description emerges to describe each object and identify its characteristics and relationships with other objects. This step resembles the process of object identification in the object-oriented languages. A short introduction to the basic concepts of object-oriented languages will be introduced and how it will be applied in the development and implementation of PIS.

3.3.1. Object orientation

In information systems, the traditional view to programming was mainly concerned with developing programs that are viewed as logical procedures. These procedures take input data, process it, and produce output data. The programmer's task was seen as developing this logic. On the contrary, object-oriented programming (OOP), as its name suggests, is oriented to objects instead of actions. It is hence oriented to information rather than to logic. This shift consequently resulted in a shift in the programming process. Its main emphasis shifted to find the objects rather than to write the logic that manipulates them (whatis.com).

This typology should help in facilitating different information processes in spatial planning tasks by identifying manageable units of information. Hanage (1995) stated "When you start to try and manage your information, you'll find that you need to break it down into 'manageable' elements - You can then think about ways to collect, store, process, and disseminate it in each area."

For a specific domain, objects present the building blocks of the language needed in this domain. These objects are organized in classes that have a common structure. Each class of objects could be described using a set of attributes. Different types of relations exist among the object in a domain. The concepts of object, class, attribute and relation will be discussed hereafter from the viewpoint of planning information.

Information objects

- An information object is understood as a piece of information about some actual things. These actual things might be physical, virtual or logical. Information objects could be called elements, units or entities.
- An information object is described as 'a capsule of information' that has its unique identification, and its own attributes; the information itself is the content of this capsule.

- The concept of information objects could be applied to the representation of physical or logical things. ‘ROAD’, ‘CITY’, ‘PERSON’, ‘MEETING’, ‘REPORT’ or ‘BUILDING’ are different examples of possible objects that could exist in the planning domain.

Classes

- If a family of objects has a set of common attributes and relations, then they are called a class. In this sense, the class ‘PERSON’ includes all the persons in their general role as a person. However, subclasses could be created from a general class, e.g. a class ‘AUTHOR’ is a subclass of ‘PERSON’. A member object of the class ‘AUTHOR’ will inherit all properties of the class ‘PERSON’ in addition to the specific properties for this subclass.
- A class of objects could be about a family of things, events or processes.
- It might include structural, behavioral, grouping, notational things.

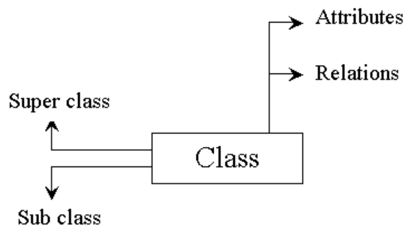


Fig. 3-21 the concept of object classes

Attributes

- Any object has a set of attributes describing its characteristics. For example, the object ‘PERSON’ is described using attributes such as ‘name’, ‘age’ and ‘address’. The object ‘ROAD’ is described using attributes such as ‘number of lanes’ and ‘maximum speed’.
- The value of a specific attribute is limited to the span of values of this attribute for the described object. An attribute’s value domain is defined by the type and the span of values that could be given to this attribute. For example, the value domain of an attribute ‘A’ is defined as an integer between x and y or the value domain of the attribute ‘author’ of the class ‘document’ is defined as a member of the class "AUTHER".
- Attributes are classified into two categories: internal and external. Internal attributes are attributes that describe the characteristics of the object. External attributes describe how the object behaves and interacts in the application e.g. is it publicly or exclusively accessible, is it available to edit or not?
- Regarding the variety of planning situations, different attributes might be available or needed for some instances of a specific class while they are not needed for other instances. This will allow the afore-mentioned applications of extended and specialized knowledge to be used where needed. Hence, an attribute should be defined either as mandatory or optional. If all attributes are defined as mandatory, then for all objects of this class all attributes must be

given, which is not reasonable in most cases. On the contrary, if all attributes are defined as optional this could lead to the missing of basic attributes that are essential for identifying the object. Hence, in the catalogue of attributes of a specific class, each attribute should be identified if it is mandatory i.e. must be defined for all instances of this class, or optional.

- Different types of measurements for an attribute's values could be distinguished as: nominal, ordinal, interval or ratio. Nominal is a qualitative value, which is non-numerical and has no ranking e.g. land uses (residential, industrial, etc.). Ordinal measurement is similar to the nominal one but has a ranking e.g. density of residential areas (high, middle, low). Interval attributes' values are numerical ordinal values that have a reference e.g. distances. Ratio attribute's value is a ranking numerical internal scale.

Relations

- Classes of objects normally have mutual relations, which represent connections or associations between two or more classes of objects e.g. a 'ROAD' is located in a 'STATE', a 'MEETING' 'is moderated by' a 'PERSON' or a 'PERSON' 'is a participant in' a 'MEETING'.

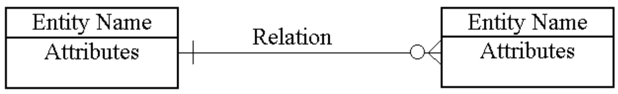


Fig. 3-22 The concept of Entity / Relation

- In general, relations could be temporal, logical, organizational, spatial, etc. as follows:

Temporal relations take the form of "x AFTER y", "x BEFOR y", etc.

  * Logical relations include different types of dependencies e.g. generalization "x IS A y", dependency "x IS A RESULT OF y", essence "x IS REQUIRED FOR y", partition "x IS A PART OF y", etc.
  * Organizational relations include such relations as association "x IS A MEMBER OF y", ownership "x BELONGS TO y", "x ASSIGNED TO y", etc.
  * Spatial relations are either topological or proximal. Topological spatial relations describe the adjacency, connectivity and containment e.g. "x LOCATED IN y", "x PART OF y", "x SURROUNDED BY y", "x BETWEEN y and z", etc. Proximal relations among spatial objects describe the closeness of non-contiguous features.

- A relation could take the following forms regarding the number of objects involved in this relation: one-to-one, one-to-many, many-to-many or many-to-one. A relation could be an object-to-object, even-to-event, or event-to-object. As in attributes, a relation could be mandatory or optional. It could also be exclusive, recursive or multiple.

Information functions

- In general, information entities or objects are handled through information functions. An information function is described as a set of actions where information objects are created, declared, communicated, processed, manipulated, documented and stored or even destroyed.
- An information function interacts with information entities through protocols that regulate this interaction according to a rules scheme. This rules scheme defines how different functions should manipulate information.
- An object can have several well-defined interfaces offering the needed attributes and relations to a process, hiding other attributes and relations.
- In classifying planning information, two aspects should be considered. The first is searching for the basic objects of planning information, its characteristics, attributes and their interrelations with each other. The second is concerned with information functions that will be applied to the information objects.

An example of object definition

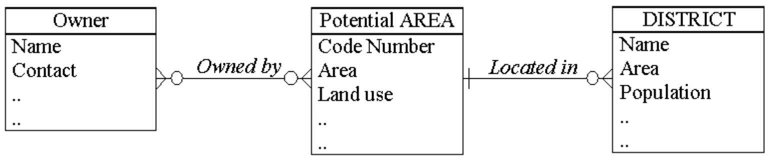


Fig. 3-23 The concept of Entity / Relation – an example

3.3.2. General attributes of planning information objects

To deal with the diversity of information objects and access rights in a multidisciplinary environment as in spatial planning, different aspects should be considered during the definition of information objects such: the type of the message, the source of the message, the location of the message in the process, the subject-matter of the message and the content of the message. In addition, different characteristics will affect how a specific information object will be dealt within the application. These aspects are considered as general attributes that apply for all information objects in spatial planning.

a. Formality: "formal information" vs. "informal information"

Formal information is the type of information that is required by or produced according to laws or regulations. This type of information is usually well defined. It has a specific source, specific categories of content and specific receivers (although it may be unlimited in number). The process of producing and processing such information is largely regulated by laws. Most of formal information takes the form of different types of plans, laws and regulations e.g. spatial planning law, land use plan, or zoning plan of a specific area. Informal information is all information that is needed, processed, produced throughout a planning process that is not specifically defined by laws and regulations. This type of information presents the majority of planning information. It also presents a higher complexity regarding the amount of information and the absence of regulations.

b. Macro and micro information objects

Macro information is large chunks of information - that include smaller pieces of information - micro information. Micro information is the smallest piece of information that has a meaning for its recipient in a specific context, e.g. spatial planning law includes different chapters dealing with different subjects. Each chapter includes different paragraphs that also deal with different cases. For a specific planning situation, some of these paragraphs might be important while the rest of the law is not relevant. If the law will be dealt with as a single chunk of information it will not be possible to access a specific piece of information easily. PIS should recognize this difference and allow grouping of micro information object into a macro one and vice versa.

c. Stability of the information object

The stability of an information object is described using two pairs of characteristic "static information" vs. "dynamic information" and "Hard information" vs. "Soft information". Static information objects will be for a very long time stable with no change e.g. the spatial planning law. A law will normally take a long time to be changed, in some cases decades. This type of information is considered a static information object, as it will not be changed in the process. An example of a dynamic information object, it could be the state of approval for establishing a large infrastructure project, e.g. an airport or the planning for a new residential district in a city. If the airport is approved it would affect the plans of the residential area regarding the resulting noise of the air traffic. An information object that describes such a subject will be updated in short terms. This type of information is considered a dynamic or temporary. The main consideration regarding how a planning information system deals with these different types will result in: which information function should be available to manipulate a specific information object according to its type?

d. Object composition

Another classification could be according to the composition of an information object or its position in the hierarchy of information objects.

- Primary information elements: The main characteristic of a primary information object is that it stands alone and does not refer to other information elements. In other words, a primary information object is about something that exists independent of other things that are represented as information objects e.g. the class actor.

- Secondary information: A secondary information object does not stand-alone; it refers to one or more of primary information objects. In other words, a secondary information object represents something whose existence is dependent on other things that are regarded as primary information objects, e.g. a document.
- Ternary information elements: The main characteristic of a ternary information object is that it refers to one or more of secondary information objects. In addition, it could also refer to other primary information objects. In other words, an information object in this category is about something whose existence is dependent on other things that are regarded as secondary information objects. An example for this category could be an event, which is related to a specific subject, in a specific place with participating actors.

e. Access context

Access context is related to the context where an information object is circulated. Three types of information objects could be distinguished regarding these criteria, namely internal, external and transferable. Internal information objects are limited to internal participants in the planning process, e.g. meeting protocols or agendas. In some cases it is even restricted to only a sub group of participants e.g. a confidential note. External information objects are information objects that are produced or processed outside the planning process but are related to the process e.g. different articles about the subject-matter of planning which is only linked to the PIS. There is third type information that is transferable information. A transferable information object is an information object that is externalized from the internal process to be publicly available or to be exchanged with some external actors.

The main concern of PIS regarding these criteria is to facilitate presenting information objects in the corresponding context. In addition, it should support facilitating the different access rights for each group of users to the different information objects.

3.4. Conclusion

- The need for studying the typology of planning information as a first step towards a common language in spatial planning processes emerges from different aspects:
  - The territory of spatial planning is multi perspective and interdisciplinary. The information that is processed or produced in a planning situation is from various professional backgrounds.
  - The planning process is collaborative and involves a large number of actors that would participate, affect or be affected by the outcomes of the planning.

* Planning information is characterized of being from different sources. It is produced by different individuals or organizations with different qualities and often using different standards.

- The needed language for planning information consists of two basic components. The first component includes the objects or the vocabulary of this language. The second component consists of the rules that govern how these objects should be used, i.e. the grammar. It is one of the basic steps in developing PIS to identify these two components of the used language.
- Each type of information is used, processed or produced in an information process. These information processes take place in a variety of planning information domains. These three concepts, i.e. information domains, information processes and information objects are argued to be crucial for the development and implementation of planning information systems.

- Three main information domains could be identified in spatial planning. These domains are:
  * The subject-matter domain of planning: includes information objects that are related to features or things of the real world in a specific spatial context.
  * The process domain: includes information objects that are related to a specific planning process which is dealing with a specific subject-matter,
  * The planning knowledge domain: includes information objects that are mostly specialized knowledge, which exist independent of a specific planning situation. It includes information objects such as laws, regulations and methodological knowledge.
- The identification of these domains affects the development and implementation of PIS in the following aspects.
  * Each of these domains includes different classes of information objects that have different attributes, coverage and live time.
  * In each of these domains, different information processes are required.
  * The target group in each of these domains is different.

- Spatial planning is a process woven of different information processes. An information process is any process where information is processed, communicated or produced.
- Information input in planning processes includes normative and empirical information. Planning produces information output based on input. The major output information is decisions and proposals of actions regarding the planning problem. Throughout the planning process, different types of coordination and communication information are produced and processed.

- Analysis of the information processes in spatial planning regarding the participating actors in the process includes: information producers, information providers and information consumers.
- Different information processes are identified in the spatial planning. Among these information processes that are considered essential for any planning situation are decision-making, coordination and communication.

Decision-making

- Facing alternative courses of action to achieve a goal or a desired state, the task of planning is to decide amongst these alternative actions. Different planning approaches have different methodologies in describing and solving decision situations.
- The basic decision problem in spatial planning could be formulated in the following terms: given limited resources (time, capacity, personnel, money, etc.), a variety of possibilities (alternative actions) and partial knowledge to choose the action with the highest probable future utility. This should be done under uncertain circumstances “exogenous factors” that could not be influenced.
- Decision-making in spatial planning could be described as a complex of sequences of decisions. Each decision presents a circumstance for other decisions.
- For PIS to support decision making in spatial planning it should facilitate exploring different alternative courses of actions, the expected outcomes of these actions and the circumstances that might influence these outcomes. Then, it should make this information accessible for the participating actors.

Coordination

- Spatial planning as a process is a social process among individuals who often come from different professional backgrounds. These processes are inherently collaborative processes, hence, requiring the negotiation and the reconciliation of different views, perspectives, vocabularies and knowledge bases associated with a problem-solving situation.
- Coordination in spatial planning could be classified into coordination of spatial activities, coordination in planning processes and coordination of information.
- Regarding coordination of spatial activities, PIS should support illustrating the interdependencies among different activities with spatial impacts on a specific spatial context, by establishing an overview about these activities and then keeping this overview up-to-date and available for the concerned actors. This might facilitates the early identification of conflicting interests and expected problems.
- PIS could support the coordination of the planning process, by coordinating the process and the various activities in such a process. It is important to categorize the participating actors, to

identify the goal and objectives of the process, the tasks that should be conducted to achieve these goals, the time plans and the interdependencies among these tasks.

Communication

- PIS could be used to support different types of communication in spatial planning in the subject-matter domain, in the process domain and in the information domain.
- For communication to be efficient using PIS, a common language among participating actors is essential.
- Implementation of PIS should support innovative ways of communication that use problem-solving communication rather than the formal process-oriented communication.
- For PIS to support communication in spatial planning, it should consider the differences between each pair of the following types communication: internal communication vs. external communication, introvert communication vs. extrovert communication and focused communication vs. nonselective communication.

- An information object is understood as a piece of information about some actual things. These actual things might be physical, virtual or logical.
- If a family of objects has a set of common attributes and relations, then they are called a class.
- Each class of objects has a set of attributes and relations that describe the characteristics of this object.
- In spatial planning, a variety of information objects could be identified in different information processes and in the different information domains. Some of these objects could be reused in different planning situations and some are specific for a certain planning situation.

4. Conceptual Bases of PIS

In the preceding the chapter main emphasis was devoted to setting an order to deal with the variety of planning information by identifying the main information domains, information processes and information objects in different spatial planning situations. This chapter is concerned mainly with setting the conceptual framework of PIS. The first step to set this framework is to determine the pre-requirements that should be considered in PIS based on the afore-mentioned characteristics. Then it will facilitate defining the basic criteria that should be considered in evaluating different technical and conceptual possibilities for the implementation of these systems.

As a preliminary step to achieve this aim, this chapter starts by exploring the meaning of the term “system”. Then the basic pre-requirements of PIS will be introduced and discussed. Afterwards the basic criteria that should be considered in the development and in the implementation of PIS will be discussed regarding the specific characteristics of the spatial problems, the planning processes and the characteristics of humans in processing information. These criteria should be considered in the conceptual, the technical and the operative aspects of PIS. After that, the proposed general structure of PIS will be introduced. This general structure includes the basic components of PIS that would be essential for supporting planning information processes under different circumstances.

4.1. Introduction to “systems”

The discussion of the term “system” is aimed at finding answers for the following questions: What is meant by the word “system”? What are the criteria that should be available in something to be called a system? What are the basic components of any system? This discussion will start by exploring the semantic meaning of the term ‘system’. Then it will be discussed from the point of view of the systems theory.

Semantically, the word "system" could be understood in three senses: a set of elements, a set of methods or a set of principles . Different dictionaries give different definitions for these three senses as well as combinations of more than one sense. Here is a survey of different meanings of this term.

Sense 1: a system is defined as a group of independent, but interrelated, elements comprising a unified whole (WordNet 2001). Several alternatives of this sense in different dictionaries are summarized in the following table.

A	→ set → collection → group → combination	of	→ connected → independent → interrelated → interacting → related	→ components → elements → items → devices → artifact	→ comprising → forming → organized in → operate together → organized for → designed to	→ a unified whole → a complex whole → for a common purpose → work as a coherent unit

The common aspect in the above listed group of definitions is the basic concept of a set of things (components; elements; items; devices or artifacts) that are connected or related together. Some definitions just emphasize that the set of elements should form a unified whole to be a system. The second group of definitions went beyond the unified whole to emphasize on the aspect of a common purpose of the set of elements.

Sense 2: a system is defined as a method or a set of procedures for achieving something (Encarta, 1999). Here is a survey of different alternatives of this sense in different dictionaries.

A	→ way → process → procedure → set of procedures → method	of	→ doing → obtaining → achieving	→ things → an objective → something

This sense goes beyond the previous one. It concentrates on the functional aspect of a system rather than the structural one; it concentrates more on how a system works than on what a system consists of. In other words, this sense considers a system as how something operates to achieve its predefined objective.

Sense 3: here a system is defined as a complex of methods or rules governing behavior (WordNet, 2001). The following table includes a summary of different alternatives of this sense in different dictionaries.

A	→ complex → scheme	of	→ methods → rules → ideas → principles	→ governing behavior

This sense is a step further than the preceding one. It concentrates on the scheme or the set of rules that defines how a set of components should behave in a procedure to achieve its goal or objective.

While these three senses are dealt with, semantically, as alternative meanings of the term “system”, I would prefer to consider them as various aspects of any system. Any system should inherit the three aspects: a set of components, a set of methods and a set of rules. In addition, a system should have an objective.

Systems theory goes beyond these semantic definitions to focus on the arrangement of and relations between the components of a system which connect them into a whole, rather than reducing a system to the properties of its parts or components (Heylighen & Joslyn, 1992). Hence, a comprehensive definition of the term “system” could be: “a combination of interdependent - or independent but interrelated - components that are organized in a complex whole, that operate together to achieve an objective. Meanwhile in achieving their objectives, these components follow a set of methods or procedures. In addition, it is governed by a scheme of principles and rules. From the above-mentioned definition, four main components are defined as primary in any system. These components are:

- an objective,
- a set of components,
- a set of methods or procedures, and
- a scheme of rules that governs how system’s components behave.

This discussion leads to several questions regarding PIS such as: What are the goals and the objectives of PIS? What are the tasks that PIS should support? What are the main functions that are needed to accomplish these tasks? What are the main components of PIS? In the following sections, these four aspects will be discussed.

4.2. Aims and tasks of a PIS

The general aim of PIS is to support different information processes in spatial planning. Rittel (1982) argues that the search for better planning systems is identical to the construction of better planning information systems. However, discrepancy of perception among information specialists and planners, regarding the application of information systems in planning, is apparent in many planning situations. In different situations, it was clear that reaching a common perception was complicated, and was reflected on the unsatisfactory results of the project. The traditional concept of implementing information systems is sooner confronted with the vague formulated requirements of planners (von Rotz 1989).

Confronted with the new developments of the informational society, it is the planners’ burden to review their theories and instruments to meet the evolving and the new requirements of planning and meeting the ever-changing circumstances of planning for spatial development. Considering the nature of spatial problems and the characteristics of spatial planning process, it is important for planners to distinguish routine and non-routine information processes in spatial planning, and then support each type with the appropriate tools.

The main difference between PIS and commercial produced general purpose information systems emerged from the basic argument which implies that: each planning information system should by based on a hypothesis about the problem that should to be solved, the participating actors in the process, the types of information that are required to make the needed decisions.

In general, planning information systems are aimed at facilitating planning information processes in a specific planning context. That includes allowing different participants, in a specific planning context, to participate in handling and communicating different planning information in a collaborative manner. However, the sole accumulation and storage of planning information are not enough to make PIS useful as a supporting tool for planning processes. It is generally known that the application of information systems to decision-making and design processes, in the form of putting data and information on a computer, is not per se an advantage for the process and in some cases it is a burden. The main task of PIS is to promote structuring planning information while dealing with the unstructured and informal information that represent an important part in planning.

However, it is important to ensure that structuring and networking of information is not a goal in itself but it is a way to a further goal that is giving an aid for planning process as a whole. To bring the appropriate aid, PIS is thought of as a part of the planning process where tasks are accomplished, information is organized and stored as a part of the processes and not as an additional and separate task. This will enable using information systems in new ways by evolving from being a facility for accumulating and preserving information to a platform for networking and sharing knowledge that is processed and produced in a planning process (Conklin 1996). This platform should network different information processes in planning. In doing this, it supports keeping different actors in touch with the planning situation and the actual available knowledge. Consequently, it facilitates the collaborative exploration of planning problems. In addition, PIS should allow identifying where information is missing. In conducting these tasks, PIS would act as the nervous system and the memory of the human body. It would be a multi-dimensional, multi-level, multi-disciplinary, multi-tasking, multi-media system and “multiparty environment”.

To accomplish this general aim, a PIS in a specific planning situation should fulfill a set of specific objectives. These objectives could vary from one situation to another. In different planning situations different objects, functions and rules schemes could be included in the system. To achieve this aim, a PIS should support different tasks related to information such as: collaborative exploration of planning matters, organization of information in the planning process, facilitating recalling and exchanging of planning knowledge, collaborative exploration of solution direction and the development of plan proposals, etc. These tasks are briefly introduced in the following paragraphs.

a. Collaborative exploration of planning matters

For decades, it was enough to use cartographic representation to establish the overview of a specific problem. It was possible to link further documents and information. However more and more information that is not possible to organize, link or call in the normal ways, is creating an obstruction for many planning tasks (Maurer 1988). Regarding the complexity of spatial problems, and the increasing mass of information that is related to these problems, PIS should support exploration of planning situation in different contexts and from different perspectives. For exploring spatial problems without overloading all participating actors with masses of information and overwhelming them with details, two types of explorations are important: 1) the spatial and 2) the chronological overviews.

1. The spatial overview: Understanding problem situations and solving them could not be achieved by the sole collection of information. It is important to ensure that the main task of PIS, in the subject-matter domain, is not to support the pure accumulation of descriptive data sets. This might lead to losing the overview under the pressure and the bulk of details, number of events, and the impact of professional, political, and personal conflicts. If the overview is lost, this might lead to the failure of judgment of the situation, and then to steer the planning in the wrong direction (Maurer 1995). Taking the interconnectivity and the nature of planning information into consideration, the task of PIS is to facilitate exploring the subject matter of planning, searching for problem solution or conflict resolution.

This overview should include the ongoing activities and the existing problems and potentials in the planning area and then try to keep this overview up-to-date. For this overview to be useful, it should be organized in a way that presents the interdependencies and relations among the included elements. It also includes key figures that present indicators about the circumstances of the subject matter (e.g. population of a city, number of jobs and consumption of residential area per capita). In creating this overview only major issues and activities, which are relevant and have importance to the region, should be included so that planners, decision-makers and other actors are not lost in huge and irrelevant information. When more specialized information is collected for a specific part of the problem this will not overload the overview as it will be organized on a lower level of the hierarchy. It should also ensure that no specific issue is ignored when making a decision with spatial impacts.

This overview would allow different actors to integrate these components in a comprehensive and integrated overview on the region. This overview should be available for all participating actors in the process including decision makers, planners and investors. It would act as a tool to overcome the regional conflict across-border and across-organization by interconnecting knowledge from different actors and making it accessible to others and then keeping it up-to-date so that actors have access to the current state of knowledge. However, in establishing such an overview in a collaborative manner, it must be considered that different actors have different access rights.

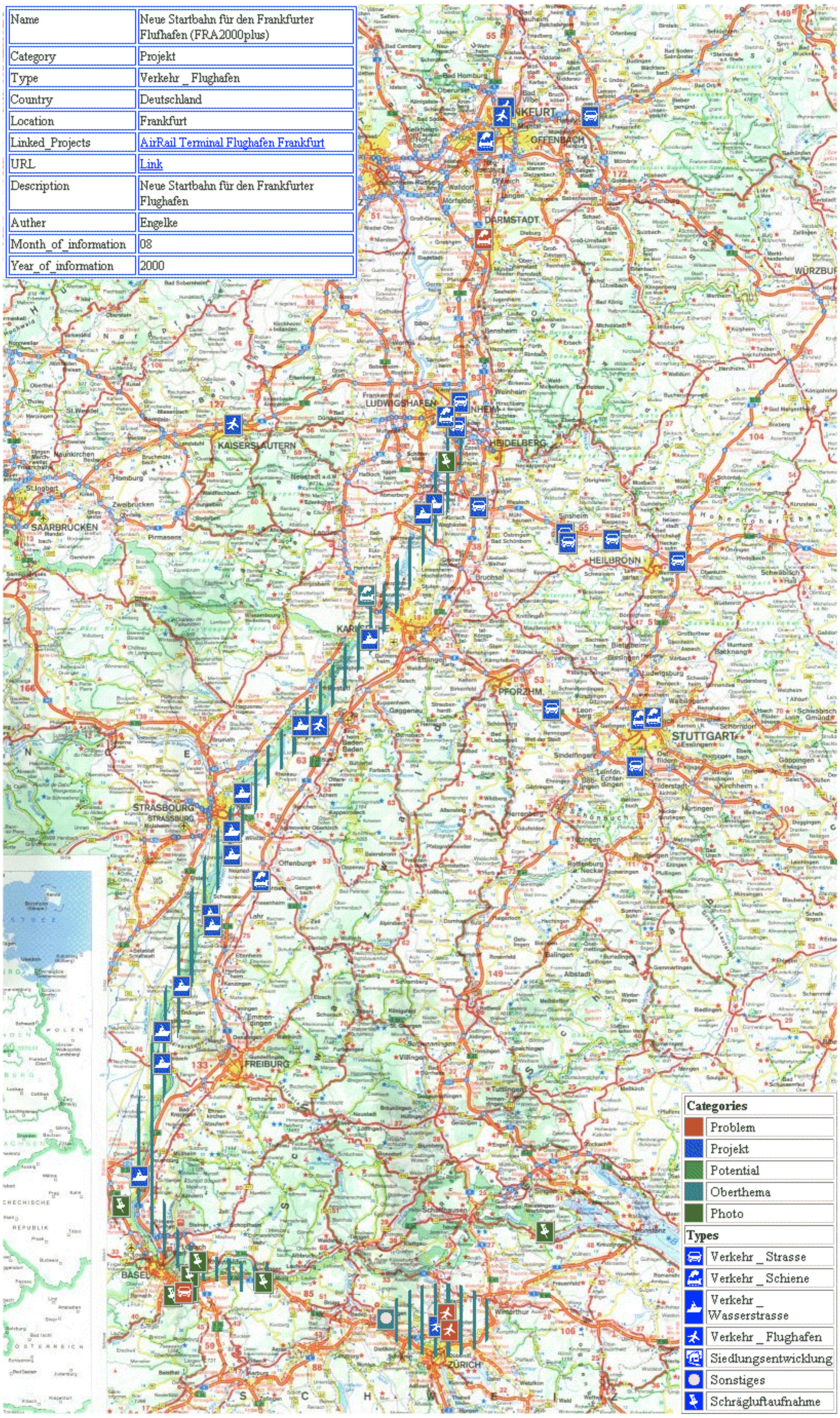


Fig. 4-1 An example of the spatial overview about spatial activities in the upper Rhine valley case study
Source: http://www.isl-projekte.uni-karlsruhe.de/oberrhein/

An example of the spatial overview: This example illustrates the spatial overview of different activities that have spatial impacts in the Upper-Rhine valley region. It illustrates planned and ongoing project, problems and conflicts. (This case is discussed in details in a different paper: Elgendy, Engelke & beck 2001)

The needed overview would include information about ongoing activities, problems, conflicts and potentials in the area as outlined here below:

- It should represent the ongoing *activities* and their impacts on other activities either positively or negatively. Positive impacts could be in the form of added value to the region. On the contrary, negative impacts might take the form of urban, ecological and social costs. These ongoing activities are not limited to spatial development projects, but they cover different types of activities as well as ongoing planning processes. These planning and development activities could be in the subject area as well as in other areas that might affect the subject area. They also include the adopted work programs of different actors that have or might have spatial impacts.
- Observing ongoing activities on a region in an integrated manner aims at maximizing the benefits by promoting synergies among these activities. It also aims at minimizing the *conflicts* that might emerge from these activities by coordinating spatial activities in this area.
- It should include major *problems* in the region and the nature of each. Then to allow participating actors in defining priority areas of action which facilitate the efficient use of the limited resources (investments)
- It should include development *potentials* in the area. These potentials should not only be limited to the existing potentials but also they should predict expected potentials in the future.

This overview should be available for all concerned actors in this area to keep an eye on what is going on in the region before making a decision with spatial impacts. To create this overview and to define what are the major issues that should be included in the system, main actors should define these issues and which information should be included according to their needs. That means a system that serves all cases, will not be suitable. A system should be developed to fit the regional circumstances and the needs of the potential users.

Such an overview should help the concerned actors in:

- maximizing the benefits, minimizing the conflicts and defining the gaps in their activities;
- estimating the positive or negative effects of the ongoing activities on both the existing and future conditions,
- defining how to integrate these components together in a comprehensive manner regarding the overall strategy for development in the area,
- setting priority areas for action to optimize the use of the limited resources.

2. The chronological overview: Spatial activities are normally realized over several years and sometimes over several decades. Different activities are found in different implementation phases others are still in planning phases. The chronological overview is a representation of both ongoing and planned activities on the time axe. It includes phases of different projects and plans as well as planned activities. It will be then possible to observe how the region will be in different phases of development and then to be able to realize if conflicts or bottlenecks could happen in the future. It also includes main events in the future that are related to spatial development e.g. for specific activities it will be needed to define what is needed to be done, to realize a specific activity. The chronological overview represents a similar function as the spatial overview but on the time line. It includes aspects such as:

- When different activities or phases will start or end?
- Which dead lines should be considered?
- Are there interdependencies with other activities or decisions regarding the time dimensions?
- When different potentials are expected to be available for developments?

b. Organization of information in the planning process

By implementing PIS in the process domain, it should support the planning processes by facilitating coordination, organization, communication and documentation in the planning process as mentioned earlier. In this domain, PIS should deal with information objects such as: documents, directories, addresses, timetables, events, meeting protocols, announcements, etc. The directory component, for example, should contain a list of the development-related organizations in the area. It might include a list of relevant legislations. To support all the above-mentioned information tasks, it will be also essential that PIS supports the internal communication among the involved actors in the process. In addition, it should support external communication with external actors.

It is also important for PIS to facilitate exchanging planning information between the different levels of applications. There is the personal planning information system where a planner organizes his personal information. Then there is the planning information system for a group of actors who are conducting a planning task together. A third level would be the public part of the system, where parts of the planning information are published for the public to give them some information about the planning task, to support consensus building for a specific development or for public participation. There are also several project information systems.

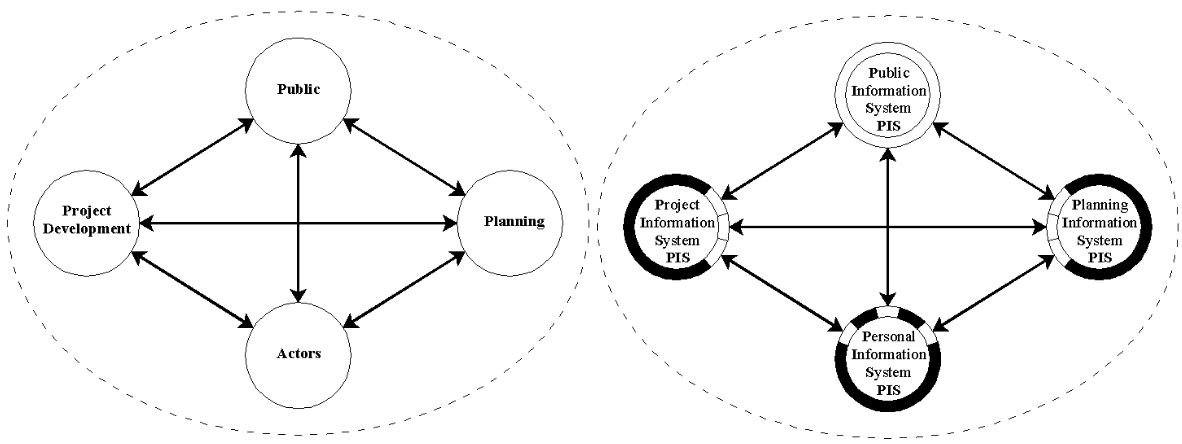


Fig. 4-2 Different levels of application of PIS

c. Facilitating recalling and exchanging of planning knowledge

By implementing PIS in the planning knowledge domain, it should facilitate the management of planning knowledge that is used or produced in planning situations. In addition, it should facilitate the recall of other experiences. It should support visualization, different searching tools, and graphical interface to browse this information.

Case studies are normally related to a specific spatial context and a specific type of problem. However lessons learned form these case studies, either form success or failure, could be useful for other situations. Case studies should then be organized both spatially as well as typologically. A user in a planning situation will be able to browse these cases to find out if some cases might help him for conducting his task. This leads to an accumulation of knowledge, which in its turn leads to saving time and effort by avoiding the solving of each problem as a unique one.

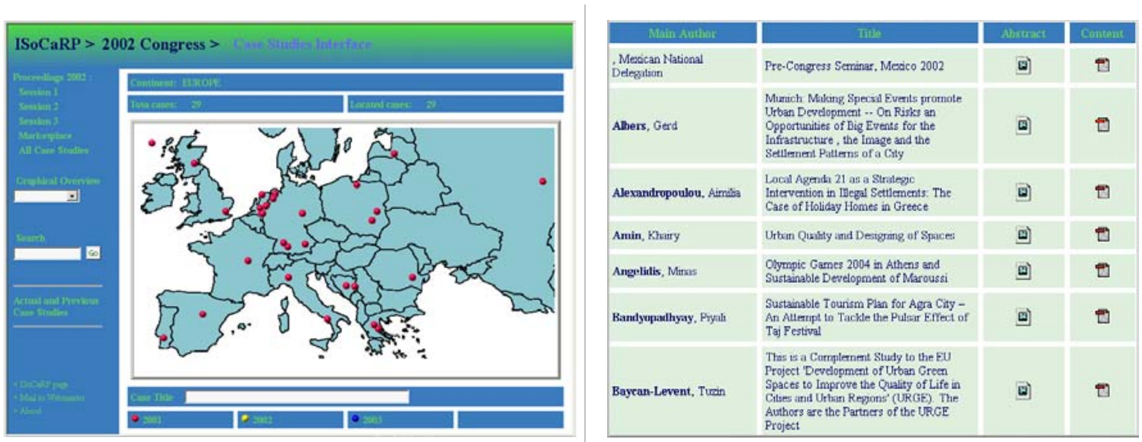


Fig. 4-3 An example of a PIS that facilitates the exchange of knowledge and experiences
Source: http: http://www.isocarp.org/projects/case_studies/case_int/index.htm

ISoCaRP Case studies internet platform is developed by: Elgendy, Engelke. This internet platform is aimed at facilitating the exchange of knowledge and experiences among the participants in ISoCaRP conferences. These case studies are from different countries and are dealing with a different theme each year.
(This case is described in details in Engelke 2002)

d. Collaborative exploration of solution direction and the development of plan proposals

As mentioned earlier, the planners' task is to solve the spatial problems and to resolute conflicts that are related to spatial activities. It will be essential for PIS to support the exploration of solution alternatives and the argumentation about these alternatives.

4.3. Conceptual criteria of PIS

The primary function of PIS is to facilitate an information platform that supports processing and production of different types of planning information during different information processes in different information domains. Consequently, it should allow different participants in a specific planning context to disseminate, exchange, maintain and use related knowledge to this planning context. To achieve this aim different aspects should be considered. These aspects are related to the afore-mentioned characteristics of spatial problems, spatial planning processes and planning information as well as the characteristics of humans in processing information. These characteristics are discussed here below.

The main characteristics of planning subjects that should be considered in developing of PIS include the following aspects:

- Spatial problems have different types of interconnectivity such as a) the interconnectivity between different levels of planning, b) the interconnectivity between the problem space and the solution space and c) the interconnectivity among different spatial activities.
- Planning problems and spatial contexts are not static. They change during the planning process. This aspect is related also to the time lag between an action and the outcomes of this action in the spatial context.

Regarding the planning process, PIS should consider the following characteristics:

- Planning is a continuous process that takes place normally in a collaborative environment among a large number of actors that are spread over different organizations.
- These actors have different backgrounds, interests, roles, responsibilities and rights in planning process.
- These actors need different requirements of planning information and they usually have different rights and duties with respect to this information. Three groups of actors could be identified regarding their information suppliers, information consumers, and information administrators,

Regarding planning information, the following aspects play an important role in the development and implementation of PIS:

- The needed information and knowledge to solve a complex spatial problem are neither completely available nor clearly known at the beginning of the process.
- The planners' perception of a specific situation evolves as they attempt to solve the problem.
- Different types of information are obtained from different sources with different formats and qualities. It is important to understand the background of the information and to understand it,

- Available information is not static, it changes throughout the process. It loses its precision rapidly.

In addition, PIS should consider some specific characteristics of the human's processing and the use of information, such as:

- The capacity of the human mind in simultaneous processing of information is limited. Different methods of recoding information should be considered to add more dimensions to information.
- The human perception of information is associative. Different pieces of information are not used in a fragmented manner. It is then important to consider the relation between different pieces of information.
- The human use of information is selective.

It is essential that PIS should be designed, developed and implemented keeping in mind these characteristics. These characteristics affect the system structure, the system organization, the functions and the system content.

Regarding the system structure, it should connect distributed participating actors and information. Meanwhile it should facilitate decentralized management of planning information with minimum effort and maximum efficiency while considering the different responsibilities and rights of the different groups of actors. In addition, it should be open to other information systems in the process to make use of available information and to avoid duplication of information production.

Regarding the system functionality and content, an additional set of criteria is considered important namely: hierarchy, modularity, interactivity, association, etc. These criteria affect the conceptualization level, the technical development and the operational measures of PIS. The following set of criteria is essential in the development of PIS:

- It should link fragmented and distributed information;
- It should utilize access for different actors apart from time and place;
- It should support different types and formats of planning information;
- It should facilitate updating information with a minimum effort;
- It should sustain different access rights to information;
- It should facilitate accessing the same information in different contexts;

In the following sections the conceptual criteria that should be considered in the development of PIS are explored to illustrate why each of them is important and to identify how each criteria might affect the system structure, organization and content.

4.3.1. A decentralized and interconnected system

PIS has a main function that is to facilitate networking different information processes, which are normally conducted in a scattered manner by a variety of actors. It should be principally possible in a PIS that each actor can autonomously use, communicate and recall different types of planning information, regardless of his location or time and with minimal or no need for help from a central support point. However, the concept of decentralization does not mean the absence of order. It is essential, to differentiate between participating actors according to their roles in the process.

The concept of decentralization is applied using the following rule "different places, different times and different roles". This rule is not only applied regarding the participating actors in the system but it is also applied on the information level. This leads to the concept of planning information system as a platform that links planning information of different agencies and actors within a specific planning context. Each actor participates with his own information and knowledge by making them available to other actors according to the agreed upon access scheme. So that each actor will maintain his specific information while all participants have access to the information at any time according to their access rights. Decentralization is applied on the following three aspects: a) the supply of content, b) the management of content, and c) the access to the content.

The configuration of decentralization in PIS should be decided regarding the different circumstances including the target and the scope of the planning process. On one hand, there are fully central systems where central supply, central administration and central access are applied. On the other hand, there are systems with high levels of decentralization: distributed supply, distributed administration, and distributed access. Between these two cases, there are different combinations that could be applied.

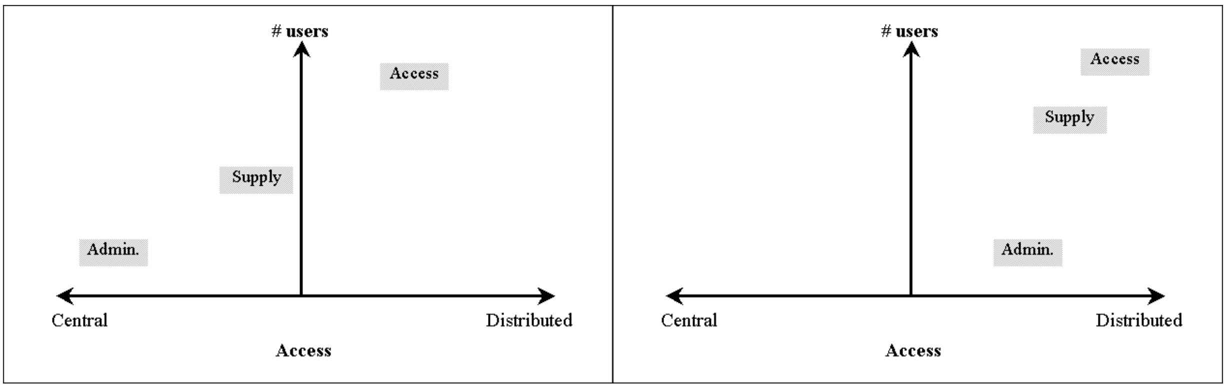


Fig. 4-4 Centralization of a PIS (to the left case A and to the right case B)

Figure 4.4 illustrates two different configurations of PIS in respect to the concept of decentralization. On the horizontal axe, the centrality degree increases from the left to the right. While on the vertical axis the number of the users is plotted. In each graph, each of the three activity groups is plotted according to the centrality grade and number of users participating in these activities. In both cases, administration is limited to a small number of users, which is reasonable. In case 'A', administration is central while in case ‘B’ administration is decentralized while it is also limited to a few number of users. In case ‘A’, regarding information supply, it is centralized and limited to a relatively small number of users while in case ‘B’ a larger number of distributed users are participating in supplying information.

4.3.2. An open system

Although information systems are used in planning and decision making for several decades, different agencies adopted different information technology policies, which created more problems in the process of information flow in the planning process. Murdick describes this situation as "islands of mechanization" (van Heldn, 1994). For PIS to be integrated in the information landscape in a planning process and to avoid creating an additional island of mechanization, it should be designed as an open system. From a systems theory viewpoint, a system is considered an open system if it interacts with the surrounding environment. This interaction has two components: input, that is what enters the system from the outside, and output, that what leaves the system to the outside. In this process, the system is not passive. It applies some processes on the input to produce the output, this process is called the ‘throughput’. A system has a boundary that distinguishes what belongs to the system and what not. All things outside the system’s boundary, where interactions with the system occur, are called the system’s environment (Heylighen 1998) as shown in Fig. 4.5.

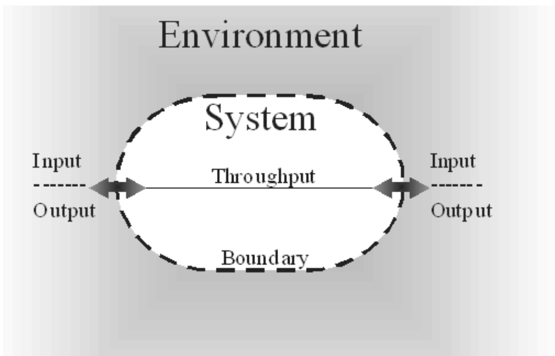


Fig. 4-5 The concept of an open system

In the environment of a planning process, different information systems are implemented in the daily work of different actors, it is essential for PIS to be an open system from both ends. In the input side, it should be able to import information from different available systems. From the output side it should have functions to import results and information to be used and manipulated in different stranded programs. A PIS is not a replacement of existing information systems but it aims at connecting these different systems. PIS acts as a hub that connects distributed information and actors. As an open system, its main aim is to facilitate and support information flow throughout the planning process.

4.3.3. A dynamic system

As discussed earlier, spatial problems are not static, they change during the planning process. In addition, they have interconnections that are partially known. Moreover, the planners' knowledge of the problem situation evolves as the problem is explored (Rittel 1982). To deal with these characteristics, A PIS should be designed in a way that allows initiating the system with a core set of information elements, functions and users. Throughout the system's lifetime, the system is extended and adjusted according to the requirements of the situation. Furthermore, the experience that is gained through implementation should be considered in extending the system. For this dynamism to be possible, the system's structure should be flexible in a way that allows adopting new and changing circumstances without the need to change the whole structure or to create a new system. Additionally, the information included in the system is changing. In planning, creating the overview to the subject matter is a part of the task. Keeping this overview up-to-date is the more difficult part of this task. For keeping the collaborative overview up-to-date, each participating actor should be responsible for updating the information related to his discipline. This should allow all participating actors to get the current state of the planning subject matter. It is then essential to define which aspects are dynamic and which ones are static and then to give the corresponding users the right to update them.

4.3.4. A hierarchal system

In complex planning situations, many aspects and interconnections should be observed. Each of these aspects could be observed in different levels of abstractions and different levels of details. it is impossible for any actor to observe all these aspects in full details at the same time. This might lead to overloading his capacity of processing information and might lead to losing the overview to the important issue. The concept of hierarchy plays an important role for the organization of information in such a situation. The proposed hierarchy might take any of the following forms:

- from smaller to larger,
- from simple to complex,
- from abstract to detailed.

The concept of hierarchy is similar to the concept of super-systems and subsystems in the systems' theory. It supposes that in many cases where several systems interact together, they could be considered as a super-system while the single systems are considered as subsystems. In observing a super-system that consists of several subsystems, it would be complex to be aware of all the components of these subsystems.

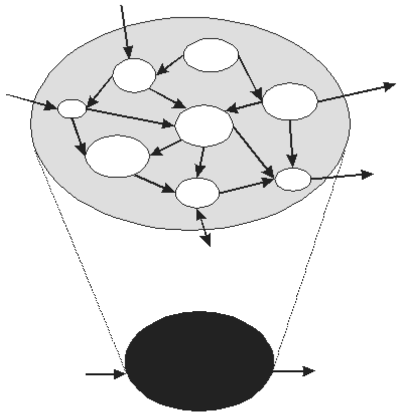


Fig. 4-6 Hierarchy in the systems theory

As illustrated in figure 4.6, a complex set of interactions and relations could be occurring between subsystems inside this super-system. However, they could be observed in different levels of details and using different levels of abstractions. At the higher level, more emphasis is given to the abstract observation, encompassing view of the whole, without paying attention to the details of the components or parts. On the contrary, at the lower level, a multitude of interacting parts could be observed but without understanding how they are organized to form a whole. In the general level of abstraction, these details will represent a burden on the observer or at least will have no value for him. Therefore, in a general level of abstraction, it could be enough and reasonable to observe only the total input and the total output of a system without considering how inputs and outputs are distributed among subsystems. This point of view considers the system as a "black box", something that takes input, and produces output, without considering what happens between the input and the output. In contrast, a system is considered a "transparent box"; if the internal processes in system could be observed. However, the black box view could be helpful also in situation where the internal details of the system could be observed but are not important (Heylighen 1998).

Taking in consideration the amount, the multi dimensional nature and the dynamism of planning information, as well as the nature of planning problems, is then essential to consider a hierarchical structure of information in PIS (Maurer 1988). The hierarchical organization of planning information facilitates the following aspects:

- Using this hierarchical organization of planning information, exploring the subject matter of planning in general terms - to achieve the initial overview - and then to delve into details of a specific element, are possible. It will be possible using this hierarchical organization to use a low grade of precision for information where it is sufficient and to use a higher grade of precision where it is needed and available. Meanwhile it facilitates representing different types of interconnections on the corresponding levels of observation.
- It allows planners to view the same problem or issue in several different contexts, thereby offering the potential to generate alternative approaches to a problem by viewing the

information in a "new light". This allows a better problem analysis by accessing the problem from different levels.

- Every solution could be observed as a problem at a lower level of abstraction, and every problem may be seen as an alternative solution at a higher level of abstraction (Hendriks &Vriens 1995). By exploring the proposed solution in different levels of abstraction it would be possible to examine this solution against general strategies on the higher levels and to examine their impacts on less abstract levels. Observing the solution on different levels of abstractions minimizes the danger of overlooking important issues that might lead to unwished side effects of the solution or higher costs because of ignoring important issues.
- Similarly, goals can be stated at various levels of abstraction in spatial planning. Using this hierarchical organization of information, general goals are examined on different levels of observation, to check their validity on less abstract levels.
- This hierarchical organization ensures that the planner will not be overloaded with many details that are not needed. This will be a possibility to overcome the earlier mentioned limited capacity of the human mind in processing information.

4.3.5. A modular system

Modularity in PIS is applied on three levels. The first level is the separation between the information, functions and representation. This separation is needed regarding: the rapid change in the field ICT, the nature of planning information as well as the different access rights to information and tools for different user groups. It should facilitate the following aspects:

- Each component of the system could be upgraded or modified without affecting other components.
- The application of new technical approaches to specific components is possible without affecting the rest of the system.
- Updating and extending the information without affecting the presentation and the functionality are also possible.

The second level of modularity in PIS is applied on the functionality level. The tools and functions in PIS are organized in a modular manner. This facilitates, on one hand, the definition of essential and optional components in each situation. On the other hand, it facilitates giving each user the corresponding functions and tools according to his access rights.

The third level of modularity is the content level. The modular organization means that each piece or parcel of content is defined as a module. This modularity facilitates organizing, accessing and maintaining the content. It also facilitates the production of different presentations based on the same content. Different modules are organized into a matrix of properties regarding the content, and other characteristics of the module. For each module, the accessibility property should be defined as well as different operative requirements such as, where is it published and who is responsible for maintaining this module. In addition, a database of the modules will be essential to organize these modules.

4.3.6. Associative organization of information

The humans' perception of the world has an associative manner. The human mind does not work with separated elements of information; rather it works with association (Bush 1945 in Shiffer 1992). When it calls or processes a piece of information, it calls other pieces of information that are associated with the main element. It is an association of thoughts, in accordance with a complex web of trails carried by the brain (Streitz 1992). This associative nature of the human mind has been observed in different contexts e.g. Collins and Loftus1975 and Murdock, 1982 (Shiffer 1992).

An example of these associations could be the thoughts of any person about a specific city, e.g. when Paris is mentioned, it is for many people, associated directly with different elements of information in the mind such as France, Eiffel tower, the river Seine, the Champs Elysees, Montmartre, names or famous writers or café shops, etc. From this example, it is important to note that association generally is characterized with the following aspects:

- Association is an individual matter. It is based on personal experiences. What makes a reasonable association to a specific individual might be irrelevant to another. It is usually subjective and in some cases wrong.
- Association occurs among information of different types and of different scales. In this example, a city as an element was associated with wholes and parts, to natural and man-made features, as well as social and human aspects.
- Association is a not a static state. It is directly related to the context of the situation. For example, if Paris is mentioned in the context of a conference about traffic and environmental problems in European cities, it is not expected that when the speaker mentions the change in Carbon dioxide emissions in Paris that the audience will make the association with Sartre.
- Association is positive when it supports a piece of information with relevant pieces of information regarding the context. It will be negative and distracting if the association occurs between irrelevant pieces of information regarding the context. This could be explained regarding the capacity of the human mind in processing information, which was discussed earlier in chapter 1.
- After a specific limit, association might turn to be negative, even if the associated information is relevant, i.e. the speaker in the above-mentioned example has associated the main piece of information with too much relevant information. Though the information is relevant, these associations will turn out to represent a burden rather than an advantage.

The opposite of association is fragmentation, where each piece of information stands alone with no relations to any other relevant pieces of information. This fragmentation of information could be found in old or poorly designed databases where information is divided into records that are not related to each other.

For design and development of planning information systems, the subject of association and fragmentation plays a major role. It is the duty of planners to define what should be associated with each other regarding the planning situation. In addition, regarding the capacity of the human mind in processing information will also be important to define where and how much association is needed.

4.3.7. Information in multi context and multi representation

Information representation plays an important role in forming the receiver's comprehension of the received message. The following aspects are among the most important factors that might affect this comprehension:

- The message representation shapes the meaning that could be extracted from its content.
- Employing different senses in receiving the information enriches the receivers' understanding of the information.
- Viewing the same information in different contexts allows the receiver to recognize the meaning of the piece of information relative to other pieces of information.

The same piece of information could be represented in different representations, using different formats and in different contexts. For example the representation of the population increase in a city, could take alphanumeric, tabular, graphical or geographical forms. The same information could also be illustrated as a simulation. Meanwhile this piece of information could be represented in different contexts. It could be relative to the total area of the city. It could be also represented relative to the absolute or the relative annual consumption of land compared to other cities.

The validity of a piece of information for the receiver is context-specific. A receiver interprets the received information relative to his needs at that moment. It is more likely that the receiver would find the information acceptable if its representation and content make it easy to understand and interpret. (Rouse 1992).

It will be important in PIS to implement different methods that facilitate the representation of the same information in different formats and in different contexts according to the user's convenience. In addition, it will be important in the information structure to organize the information in a way that allows changing the information representation. If the information is saved in a static representation, it will not be possible to change this representation. To facilitate this dynamic representation the modular structure of information and the split between the information and the representation are essential aspects. It will be also important to organize the associations between different pieces of information to allow the representation in different contexts.

4.3.8. Supply modes of planning information

The supply mode of planning information could be observed from two different viewpoints. The first is related to the comprehensiveness of the supplied information. The second is related to the way in which the information is supplied or obtained.

Inclusive vs. selective.

Taking the amount and varieties of information that could be available in a planning situation; it will be a burden on the system and on the users to include all possible information. If the volume of information grows too much, it will be difficult to keep the overview on the important information. It is important in PIS to select which information should be included in details and which should be only included in an abstract form.

Push vs. pull.

Information could be communicated in two main modes according to the relation between the receiver and the communicated information, i.e. the "pull" and the "push" modes. In the "pull" mode, the user should proactively request the information when he needs it. On the contrary, in the "push" mode, information should be supplied to a target group of users without their request. Under the push mode, the possibility is higher that the users would receive information that are not relevant to their interest, or that they receive the information not at the right time for them. In this case, it is likely that they will ignore the received information. Under the pull mode, the user will not be subject to distraction by such information. Meanwhile he could lose important information if he does not take the initiative to seek for it. (Srinivas 2002)

For the development and the implementation of PIS, both modes are important. Important information could be pushed to the target group in a compact form with only the main information. The users should request the rest of the information when they need it.

4.4. The proposed general structure of a PIS: Components of PIS

Representing a general structure of PIS is an attempt to define major components of PIS that might be needed to accomplish planning information processes under different circumstances. It also attempts to represent the relation of these components to each other and to different groups of actors. Four main components are considered the structural fundamentals of PIS i.e. planning information, functions, rules scheme and user interface. In addition to these components there are the common components of any distributed information system i.e. hardware and networking facilities.

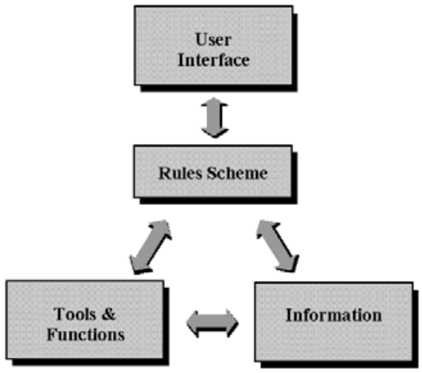


Fig. 4-7 Main components of a planning information system

The above-mentioned four main components of PIS are further divided into sub-components. The organization of PIS structure into components and sub-components facilitates the definition of the required and optional parts regarding the circumstances of the system application. In addition, as information and communication technology is witnessing continuous innovations at a very fast rate, this structure will be developed regardless of specific techniques or programs. This split between the presentation, information and functions will permit the following aspects:

- It allows the enhancement of each component and the adoption of new techniques without affecting the functionality or back-end techniques
- In case of adopting new technologies in the back-end, the presentation and the information will not be affected.
- It facilitates different presentations based on the same information.
- Updating and extending the information without affecting the presentation and the functionality.

A brief discussion of these four main components of a PIS: the information, the functions, the rules scheme and the user interface, are introduced here below.

a. The information space

Planning information that is used in any planning process should be based on a set of hypothesis about how the current problem or conflict should be solved. This information has the following characteristics:

- It is related to the different information domains in spatial planning as mentioned earlier.
- It covers different aspects of the planning process (time, space, resources and organization).
- It includes normally different media types (i.e. text, images, audio, video, maps, etc.).
- It is usually distributed spatially.

Based on the hypothesis about the problem solution and the process that is needed to develop this solution, the first step in developing a planning information system should be the definition of the planning information domains, processes and objects that should be considered in the system. Then to define its characteristics, attributes and its interconnectivities as discussed in chapter 3. This step presents setting the foundations of the common language for that specific planning process or subject.

Topologically, the information space includes basically three sorts of information objects. First, structured information that is organized in a database. Second, information that is combined as documents of different types and of different media types. Finally the Meta information, information about information that is not available e.g. links or literature index. Each of these types might be present in each of the earlier mentioned three domains of planning information.

- *Structured information* could be described as classes of objects. Different information objects are dealt with as instances of these classes. A class of information objects will include elements of information that are structurally similar i.e. having a common set of attributes. Different classes of information objects are mentioned in chapter 3.
- *Documents* are chunks of information that have a common subject and are combined in a specific layout. A document might be a text, a photo, a video, or any type of media. In PIS, documents are considered a class of information objects that has specific attribute, relations to other classes and supports specific methods. Normally, a document is represented in a PIS in two forms i.e. the document itself and meta-information about this document. A document could be related to any of the above-mentioned information domains. For example, a document that contains assessment of different solution alternatives will be related to the subject matter of planning because it is related to the content of a specific planning situation. Another document that contains the spatial planning law or planning regulations in a specific area is considered related to the discipline domain as its content effects are beyond the subject matter of the planning. Similarly, a document that contains the protocol of a project group meeting will be considered a part of the process domain as it has mainly a direct organizational nature, while a document that contains the literature list for a specific subject will be classified under the meta-knowledge domain.
- In addition, there are different pieces of information that are not directly available in the system. The system includes it only in the form of *Meta information* or information about the original information. One of the main tasks of PIS is to support meta information

b. The functions

Planning information systems are not collections of documents and information. They require a set of tools and functions that is needed to allow planners to accomplish their information tasks, and to interact with different types of available information objects. These functions and tools could be grouped into three main groups:

- A set of primary and secondary functions that is needed to handle both structured and unstructured information. This set of functions could be standardized and used in different situations. This group of functions includes database management, media management, user management and visualization.
- A set of tools and functions that considers different information processes which are needed in spatial planning such as coordination, communication, decision making, etc as discussed in chapter 3. For example, for coordination, there should be tools to deal with interdependencies and resources. For decision-making, there should be a tool to deal with alternatives and circumstances. This set of functions has similar framework in different processes, but it should be adjusted to meet the specific needs and characteristics in each planning situation.
- Tools for simulation and analysis. Each tool or function has a similar structure; it should be developed and examined for each specific situation regarding the circumstances of the current case.

c. The rules scheme

For different components of a system to interact inside the system with each other as well as with other elements in the system's environment, a rules scheme that governs these interactions is essential for the functionality of the system. For information system and consequently for planning information system, a rules scheme is considered the grammar of the system's language. It aims at setting the common accepted use of the system's object language i.e. what is allowed to be said in which situation, or if something is said in a specific context; how it should be interpreted? This scheme consists mainly of two groups of rules, namely declaration rules and access rules.

- *Declaration rules* are a set of rules that governs the declaration of different information objects including the object definition and its attributes including data types, value domains and validity rules of different attributes.
- The second group of rules includes *the access rules* of different users. Using these rules, the system deals individually with each user or a group of users according to his/their permissions; hence allowing him to handle only permitted information and using only permitted functions (i.e. a public user can only see public documents and should have no access to restricted documents. He can search for available information but he is not allowed to delete or edit it). An Authorized user can use input and editing functions. Some users could have access to some specific tools, while other users can have access to all the tools. In addition, some users can edit specific information, e.g. regarding specific theme or spatial context, while another user might have access to edit everything.

The concept of the access scheme is only possible if the system is structured in a modular way. The concept of modularity will be discussed later in this chapter. While this scheme should be very strictly respected, it should be organized in a very simple and understandable way and concentrates only on essential rules. It should be also flexible and easy to handle. In an environment where different actors have different and sometimes conflicting interests, the rules scheme should not be regarded as an obstacle. Rather, it should be viewed as the light sign in a complex traffic intersection that allows different vehicles to move smoothly though with relative constraints. The absence of these rules, which might mean the absolute freedom for all users, will result in a chaos that leads to total malfunctioning of the system. However, it is important to consider in setting this rules scheme not to exceed the optimal density of rules. Too many rules will reduce the efficiency of the system and restrict users' efficiency. In addition, if the formal rules are too tight and very complicated then it could be said that the optimal density of the rules was exceeded resulting usually in a tendency to overcome this situation by using informal rules.

d. The user interface

The user interface is the main component of the system that is directly available for the end user. It presents the gateway for all users to the system content and function. Therefore, it will be important to keep it human-centered by concentrating on the issues of practicability, acceptability, and validity Rouse (1992).

This user interface should be personalized according to access rights and preferences of each user. Consequently, he gets only access to the functions and information that he has a permission to use. The user interface allows browsing, viewing and manipulating different information types. It should support alphanumeric, tabular, graphical and geographical modes. The interface is considered more advanced if it facilitates exploring the same information in different modes and in different contexts, which allows more understanding of the subject matter of planning. In this context, Rouse (1992) argues that: "People tend to interpret the validity of information in a very context-specific manner relative to their needs at the moment. People are also more likely to find information acceptable if its format and content make it easy to understand and interpret." It allows interaction where further associations are available and needed. It should facilitate exploring the information in different contexts to improve the planner's perception of the problem. It also connects the distributed information from different sources of the participating agencies. The user can also search in these distributed databases simultaneously using different criteria and extracts information about the matching elements. To achieve such integration among different sources of information, common standards will be essential.

4.5. Conclusion

- PIS is a tool that is mainly aimed at supporting the different information processes in spatial planning processes.

- To achieve its aim, it should be able to support all or some of the following information processes in planning.
  - ∗ exploration of planning situation in different contexts and from different perspectives. This exploration should be accessible to all the participating actors in the process. Their access is organized by the rules scheme
  - ∗ exploration of solution alternatives, and argumentation about these alternatives.
  - ∗ organization of planning processes and coordination of planning efforts.
  - ∗ management of the planning knowledge that is used or produced in a planning process.
  - ∗ internal communication among the involved actors in the process and external communication with external actors.
  - ∗ coordination of spatial activities in a specific area.
- The definition of the processes that are needed in a specific planning situation is a matter of negotiation among the participating actors. In some cases, coordination of spatial activities could be the main task. While in other cases the main task would be exploring the subject matter of planning in a specific situation or organizing the planning process. It might also be mainly oriented to organizing the planning knowledge in a specific domain.
- The basic components of PIS are:
  - ∗ The information space that includes different classes of planning information,
  - ∗ A set of functions and tools that facilitates handling the information and conducting the information processes,
  - ∗ The rules scheme that regulates the use of different information objects in the form of a grammar and the access rights of different users, and
  - ∗ The user interface that facilitates the interaction between the user and the information space using the functions and the tools according to the access rights.
- To deal with the afore-mentioned characteristics that represent a set of pre requirements in the design, development and implementation of PIS, different aspects of the systems should reflect these aspects e.g. in the system structure, system organization and information organization.
- The system should facilitate accessing the information independent from place and time. However, it should consider the access rights of the various types of participating actors.
- Regarding the system structure and organization, the systems should be decentralized, interconnected and open to other information systems. Regarding the information organization, the information should be organized in a modular, hierarchical and associative manner. Based on these criteria, PIS should support accessing the same information in different contexts and in different levels of abstractions.
- The system should be designed in a way that allows initiating the system with a set of information and function that could be extended and updated.

5. Technical Bases of PIS

"A *computer is just a glorified pencil. Einstein once said, "My pencil is cleverer than I". What he meant could perhaps be put thus: armed with a pencil, we can be more than twice as clever as we are without. Armed with a computer, we can perhaps be more than a hundred times as clever as we are without; and with improving computers there need not be an upper limit to this."* (Karl Popper 1981)

Normally, human information and knowledge are stored in the long-term memory of individuals. The long-term memory of human beings has a relatively large capacity as opposite to the short-term memory, which is limited to a specific amount of chunks of information as mentioned in chapter 1. However, for information and knowledge to be externalized from the individual memory, it should be communicated with others. In ancient times, communication between two individuals or among a group of individuals required meeting at the same time and at the same place. For example for an ancient scholar to communicate his knowledge to his students, he should meet them in a specific time and in a specific place, otherwise no communication could occur. This type of communication used to be the only possibility for communication before the invention of writing and printing. However, for communication, to take place in different times and places, it needs to be stored outside this individual memory, in the form of books or any other type of media. In the absence of this external storage, people should travel to meet the individual who had the knowledge or the information, which consequently would severely limit the accumulation of human experience in the form of knowledge and information. To overcome this limitation, human beings developed the writing systems (Encyclopedia Britannica 2000). As the amounts of accumulated knowledge grew, humans have developed the library systems to collect this knowledge in some central place and then organize it and make it accessible and usable for different users. This process, though manual or paper-based, is the basic form of a system for information. It includes the basic components of a system in general, i.e. components, procedures, rules scheme and a goal.

This chapter starts by a general introduction to information systems, and then more concentration will be devoted to its applications in spatial planning. Afterwards, functions and technical criteria of PIS will be introduced. Then possible techniques for PIS will be discussed and the general structure of PIS will be presented form a technical viewpoint.

5.1. An introduction to information systems

5.1.1. Definition, components and functions

The term 'information system' is used in a multifaceted manner in different disciplines and literatures. It is broadly used as a synonym for 'database system', 'information processing system' and 'data processing system' (Bracken 1990). Fundamentally, a system, whether computerized or not, which is designed for the purposeful and meaningful processing of information, is considered an information system. Specifically, such a system accepts input in the form of data, and then processes it by composing, organizing or structuring different data items to produce information as output. The main purpose of such systems is then to collect, organize, store, process and display information in all its forms (raw data, interpreted data, knowledge, and expertise) and formats (text, video, and voice) to support operational tasks and decision-making tasks (Encyclopedia Britannica).

To accomplish its task, an information system should include the following main functions:

- Accept data input,
- Manipulate it in some way from data to information using different processes e.g. conversion, organization, structuring, modeling, visualization, etc.
- Produce information as the output.

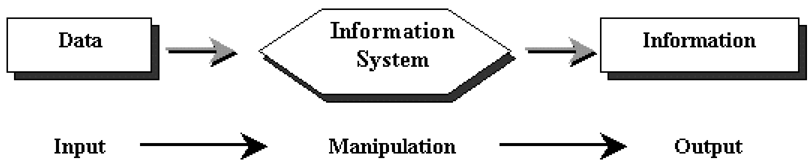


Fig. 5-1 The basic concept of an information system

An information system does not consist only of the commonly known components: information, software and hardware; it also includes the people and the procedures that are related to the system. Bracken (1990) considers the main purpose of information systems is the production of 'uncertainty-reducing' information products. He describes it as a value-adding processor, adding 'meaning' to data.

Regarding the development of planning information systems as a subclass of information systems, it would be then important to discuss the following questions: what are the main characteristics of input in respect to planning information? Which input processes should be available both to support input from other systems as well as to support direct input from individuals? Which rules scheme governs this input? Which functions are needed for which purposes? Who are the actors who should use the system? Which procedures would be governing the system? Which procedures would be supported by the system? Which types of outputs are needed?

5.1.2. Typology of information systems

Among the major questions in this study are: what is the difference between PIS and any other information systems? Why is the study of PIS needed? To approach this subject, it is important to start by discussing the different types of information systems in general and especially those related to planning and decision-making on one hand, and those concerned with spatial information on the other. Generally, information systems are not easy to be classified because of their diversity and the continuous evolution in this field.

Different classification criteria were used for different purposes and in different stages of technological evolution. Here are three of these approaches with a brief discussion of each:

- *The conventional approach:* Conventionally information systems used to be classified according to different pairs of criteria e.g. manual vs. automated, interactive vs. off-line or real-time vs. batch-processing (Britanica.com)
- *The application approach:* Information systems could be grouped into specific areas, according to their fields of application (Britanica.com 2000) e.g. offices, factories, libraries, hospitals, etc.
- *The functional approach:* Information systems could be classified, regarding their purpose, into the following main classes (Bracken 1990 & Batty 1984):
    - *Function oriented-organizational systems:* these systems are characterized by being organized to serve a particular function. They are mainly designed to assist users in the execution of their tasks and functions by attempting to structure or even automate their decision-making tasks. This ranges from routine tasks such as airline or railway ticket reservations to the most complex functions in the professional and scientific domains.
        - Support of managerial and administrative functions (serve internal functions of the organizations)
        - Support of operations and services (support the purposes for which these organizations exist)
    - *Subject-oriented information utilities*: These systems are organized around a subject theme and are designed to serve users with specific types of information.

However, these different approaches to classification are not completely separated from one another. The same information system could be classified using different sets of criteria. For example, the online archive of a city planning department that includes different plans of the city for public access, could be classified according to the conventional approach as automated and interactive; according to the application approach it will be library-oriented and according to the functional approach it will be subject-oriented. Each of these classifications could be found in the field of spatial planning. The following section introduces these different types of information systems in spatial planning.

5.2. Information systems in spatial planning

The study of information systems in planning could be approached from both the side of innovations in information systems as well as the side of planning theory. From the information systems viewpoint, three major developments could be distinguished, i.e. the main frame, the personal computer and the Internet. Each of these developments has influenced the application and the use of information systems in planning. From planning theory viewpoint, four approaches are distinguished as mentioned earlier in chapter 2, i.e. the classical, the systematic, the systems and the action approach. Each of these approaches has different requirements and applications of information systems. This section is an attempt to discuss these two viewpoints of the application of information systems in spatial planning in a cohesive way to define how innovations in information systems have affected the use of these systems in planning and in some cases and how it affected planning theory.

5.2.1. The mainframe era

During the early 1960's, the first wave of information systems' development took place by the introduction of large mainframe computers, which were characterized by the capability of running relatively large amounts of data through a predefined systems to produce a pace output. However, these early commercially produced mainframes were very expensive, very large and maintenance-intensive. In addition, users had no direct contact with the computer. Only members of the data processing department used the computer directly. Most users submitted simply lists of data or a set of punched cards to the operator. Then, predefined computing operations ran on these cards, in batch mode. The user should come back later to collect a printout. In a later development, researchers and specialized users were encouraged to learn a programming language such as FORTRAN (FORmula TRANslation language) so they could create their own programs that should also be submitted to the operator for processing (The Online Planning Journal 2000)

Application of these systems in spatial planning was mainly oriented to processing population and transportation data or to spatial modeling, that resembles some aspects of the real world either for the analysis of spatial patterns or for forecasting future developments (Batty & Densham 1996). Based on the paradigm that modeling ecological and social aspects of the real world in the form of systems is possible, these applications were the major tools in the systems' approach to planning. However, this approach and the application of information systems were criticized as being a failure for two reasons. The first is the dissociation of this planning theory from the reality of the organizational and political world in which planning takes place (Barrett & Leather 1984) and that the systems' approach is not relevant to planning decisions which have social implications. The second was a result of the failure of information systems in predicting and analyzing the patterns of future land use or issues based on spatial data.

5.2.2. The personal computer era

During the 1980's, the personal computer was introduced as a revolution in information systems. This shift from the large mainframe to personal computers (PC) resulted in a similar shift from the top-down approach that was based on remote, large-scale, database computing (Batty & Densham 1996) to a bottom-top approach based on networked, distributed computing. The PC with its desktop size made it possible for many users to enter directly their information: to use pre-programmed software, to save their information locally and to have a graphical representation of data. During this era, the application of information systems in the form of PCs in spatial planning witnessed a proliferation of tools, models and software packets that were aimed at supporting the scientific methods of the systematic approach. The application areas of information systems in spatial planning in this era ranged between operational, data organization, analysis, modeling, visualization, decision support and expert system. Hereafter is a brief description of some of these applications.

i. Modeling: the focus of computer modeling in spatial planning was mainly oriented towards either urban analysis for explaining urban structures or exploring and predicting the effects of planning on urban development. Generally, modeling could be classified into two main types. The first is graphical modeling (visualization) that includes the representation of either existing or planned urban structures. This modeling ranges from 2D simple plans to complicated 3D animated models. The second type of modeling is the mathematical modeling (simulation) which normally attempts to represent the logical structure of patterns of human behavior and the natural environment (Lloyed-jones & Erickson 1996). However, Simmonds (1986) describes those exploratory models as being only concerned with exploring logical possibilities rather than realistic and likely outcomes. In addition, while most computer models used by planners have been developed for structured-problems, most of the decision-making in planning deal with semi-structured and ill-defined problems (Langendorf 1985) and in some cases with undefined problems at all. Hence, in a complex planning or decision-making situation there is a need to start with exploring the problem in a way that supports understanding the circumstances, the possibilities and the limitations before attempting to force the problem into an existing model.

ii. Geographical information systems: GIS is a System of computer software, hardware, data, and personnel that is aimed at manipulating, analyzing and visualizing information that is tied to a spatial location. This development in the field of GIS was accompanied by a shift from mathematical modeling to the visualization, the representation, and the manipulation of spatial data in quite straightforward ways. In terms of planning and problem-solving processes, the application areas of GIS were limited. Batty & Densham (1996) argue "to date there has been very little emphasis on formal analysis, simulation and modeling and hardly any at all on design and decision-making aids." The main application areas of GIS in planning could be grouped as follows:

- Management and monitoring of urban activities;
- Optimization of site selection process;
- Undertaking impact assessments;
- The maintenance of cadastral and other geographic data;
- Production of maps and plans; etc.

Despite the considerable progress in GIS science and its relevancy to urban and regional planning, the applicability of its results is somewhat limited. This limitation could be attributed to the concentration of GIS on geographic details, which might overload the planner with details that hinder developing an overview of the problems. For planning, on the contrary, geographical details should be in the background, but correctly represented and well controlled (Batty & Harris 1992). In addition, GIS has a primary emphasis on the analysis of spatial processes and phenomena. Meanwhile, it does not directly address the specific needs of the planning process and focus only on narrow planning issues and/or only on one aspect of the planning process (Nedovic 2000).

The following table includes a comparison of some basic difference between PIS and GIS regarding the nature of the system, the type of information included in the system and the functions the system should conduct.

	PIS	**GIS**
Nature	Normative	Positive
Purpose	Aiming at changing space	Aiming at describing space
Information	Information that is processed or produced during a planning process. It covers information about space, time, organization, etc.	Information describing the earth, its features and peoples' activity on it.
Relation	Related to a specific planning context, process or subject.	Related to a specific spatial context.
Orientation	Process-, problem- or subject-oriented	Space-oriented
Processes	Collaborative exploration of planning problems Coordination Communication Decision making Documentation	Visualization Buffering Network analysis Overlaying Site selection
Development	Iterative / explorative The system can start by a core information and function and grow with use	Comprehensive The system should be complete to be useful

It is evident that considering GIS as the prime or the sole planning tool is not rational for GIS or planning. GIS is useful for specific procedures but not for all procedures. Batty and Harris (1992) argue that although GIS, if properly considered, provides very important types of support and control to many activities, they are limited by their nature to fail if they are used as the exclusive tools of analysis and planning. They support the organization of information in certain ways, but not necessarily in ways, which then support every type of production of knowledge or intelligence.

iii. Expert systems: Generally, an expert system is a computer program that simulates the judgment and behavior of an actor – individual or organization- that has expert knowledge and experience in a particular field (whatis.com). Fundamentally, an expert system consists at least of a knowledge base and a set of rules. The knowledge base contains the accumulated experience of a group of experts in a specific domain while the set of rules defines how the knowledge base should be applied to each particular situation that is described to the program. The application of expert systems is oriented towards repetitive situations in a specific domain, i.e. in a factory, in a specific specialization of medicine or in chess. These fields are considered among the best-known expert systems. In such fields, a set of specific symptoms indicates a certain problem or a direction of the problem. If a certain problem is identified, the expert system should propose the solution. If the information is not enough to identify a clear solution, the system will supply only a direction for the solution. In this case, the system will request further information to narrow the scope of the problem.

For applying expert systems in spatial planning, the planners' experiences in a specific field would be condensed into a knowledge base of logical inference, which can be formally processed by the program. Different attempts were conducted to extend expert systems by using weighting or quantification methods. These methods would be applied on the different factors and their estimated probabilities of occurrence (Lloyed-jones & Erickson 1996). However, it is apparent from analysis that the majority of spatial planning functions cannot be standardized. Most of these functions are concerned with decision-making, based on the circumstances that differ from case to case. This means that they cannot be automated by using expert systems. This implies that the functions rely on information supply systems more than on automation (van Helden 1994).

Regarding the types of problems that an expert system can deal with, its application areas in spatial planning would be mainly in fields such as systematic land use plans where the planning process is well-structured and governed with clear laws and regulations. An example of the application of expert systems in spatial planning is the project "Intelligent Land-Use Plan" that was conducted in the university of Kaiserslautern in Germany (Streich 1999). This project was aimed at developing a system for legally binding land-use planning (Bebauungspläne). This system supports the plan's development process and assists users to understand the plan and work with it. In this type of plans in Germany, there are specific requirements and specific content to be included in the plan. Such a plan should include the type of land use, the intensity of building etc. The proposed expert-system should define working steps needed to produce the plan, interdependencies among these steps, how each step should be performed and the essential background information for each step (e.g. legalization).

iv. Other applications: the above-mentioned three examples are few examples from a wide range of information systems applications in spatial planning. Further applications are found in management and administrative uses, communication support system for report writing, graphic presentations and inter- and intra departmental communication of information and information supply systems which include the straightforward supply of data and information to the public, city officials or other actors.

5.2.3. The Internet era

The Internet as a network of networks connecting hundreds of millions of computers and users throughout the world emerged in the late 1980s and extended at a fast pace throughout the 1990s and the beginnings of the 21st century. Similar to the shift that accompanied the change from the mainframe to the PCs i.e. from top-down to bottom-top approach, the Internet has changed the people's use of computers as well as how they work. While in the era of the PC the main aim was to work efficiently and produce professional documents, the Internet changed this priority towards communication and collaborative work.

Regarding the use of the Internet supported applications in spatial planning, it is important to outline the difference between planning functions and other disciplines that are directly related to it but could not be considered planning, i.e. geography, spatial analysis, urban management, facility management, visualization, city marketing, etc. This emphasis is attributed to the widespread confusion between two groups of applications. There is a variety of Internet-based applications dealing with subjects such as city official sites, online citizen service, online city marketing, visualization of urban areas, project presentation, mapping and web GIS. All these applications could not be considered planning applications as long as they are not related to spatial planning, for example in exploring problems, developing solution alternatives, argumentation about these alternatives, decision making, follow up of planning actions, organization of planning processes, etc.

As for all aspects of social and economic life, the Internet opens new horizons for spatial planning. New questions are becoming tangible. New challenges are becoming apparent. In dealing with the Internet, planning research adopted different approaches.

- The first approach dealt with the Internet and its cyberspace as an extension of the real world.
- The second considered the Internet as a communication and work environment that might affect the physical space. Hence, concentrating mainly on how the Internet will affect how people's life, work and move and consequently how it will affect the built environment.
- The third approach concentrated on how the Internet could be used to present planning information and support public participation.

- The fourth approach regarded the Internet as a potential working media for collaboration, hence, how the Internet could be used as an innovative platform for planning processes.

For spatial planning, the Internet - with its connectivity and flexibility - presents a possibility to work independently from place and time, meanwhile it allows a relatively efficient access to information. In addition, the Internet presents an optimal means of supporting planning processes where distributed and independent actors are working together while being dispersed over different organizations. Furthermore, this networked collaborative work could be useful for creating networks of professionals and experts from different countries who are dealing with similar interests. The main areas of application of the Internet as a supporting tool in spatial planning could be grouped as follows:

- Collaborative exploration of planning problems;
- Public participation and information;
- Communication and coordination in the planning process;
- Visualization of plans and plan alternatives;
- Web-GIS as far as it is concerned with planning situation, and not pure mapping;

5.3. Technical aspects regarding the proposed general structure of PIS

In this next section, PIS will be discussed from information systems' viewpoint. Starting by an introduction of the technical criteria that are essential to fulfill the conceptual criteria presented in chapter 4. Afterwards the technical basics of the systems will be presented aiming at illustrating how the proposed structure of PIS could be realized. The chapter will be concluded by a comparison of the basic differences between PIS on one hand and other systems on the other.

5.3.1. Technical criteria of PIS

Taking in consideration the afore-mentioned characteristics of spatial problems, planning processes, planning information and the capacity of humans in processing information, different sets of conceptual criteria are defined in the preceding chapter. These characteristics and the resulting criteria affect the technical basis for developing PIS as following.

- Regarding the nature of planning problems and planning information, the proposed technique should consider the following criteria:
    - Planning deals with different types and formats of information, hence it should allow a simple multimedia environment;
    - Planning deals with fragmented and distributed information resources, hence it should be capable of linking and connecting;
    - Planning information is dynamic, it is changing and growing, thus it should facilitate updating information with a minimum effort;

    * Planning problems are multifaceted and interconnected, therefore it should facilitate representing the same information in different contexts;
- Regarding the nature of planning processes that could not be organized in routines, the proposed technique should regard the following aspects:
    * Planning processes are collaborative in nature with actors from different organizations, therefore it should facilitate access for different actors apart from time and place;
    * Not all actors have the same role in the planning process consequently it should sustain different access rights to the system; and
    * Planning processes are generic in nature. In each case, different circumstances are dominant. Hence, PIS should be adapted to fulfill the different requirements that might be needed in different processes.

Based on the above-mentioned criteria, the Internet and its innovative technologies present a potential medium for establishing PIS as it fulfils principally each of the above-mentioned essential criteria for the proposed system.

- It supports different types and formats of media while using regular and simple standards;
- It links fragmented and distributed information from different sources (Hypermedia);
- It facilitates access for different actors apart from time and place with different access rights;
- It facilitates online updating of information with a minimum effort;
- Using a well structured concept, the same information could be accessed in different contexts;
- Using standard programming languages, the system could be extended or modified.

It could be said that the Internet supports the basic rule that was discussed earlier which implies that the supply and the use of information in planning processes should fulfill the following criteria "different places, different times, different media and different roles". The proposed structure of PIS uses the Internet and its innovative technologies as the technical base for the system. These techniques include among others the World Wide Web (WWW), hypertext, hypermedia, dynamic web pages, databanks, etc. Each of these techniques is discussed briefly in the following sections.

5.3.2. The Internet

The Internet is a worldwide system of computer networks - a network of networks in which users from any computer can, if they have permission, get information from any other computer. It was conceived by the Advanced Research Projects Agency (ARPA) of the U.S. government in 1969 and was first known as the Advanced Research Projects Agency Network (ARPANet). The original aim was to create a network that would allow users of a research computer at one university to be able to "talk to" research computers at other universities. A side benefit of ARPANet's design was that, because messages could be routed or rerouted in more than one direction, the network could continue to function even if parts of it were destroyed in the event of a military attack or any other disaster (whatis.com). Figure 5.2 illustrates the concept "the network of networks".

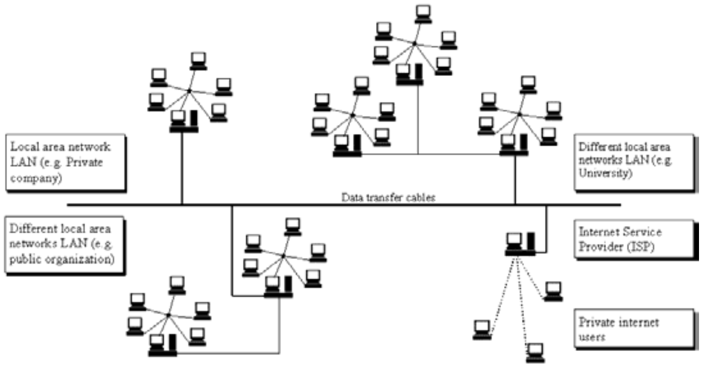


Fig. 5-2 The concept of the internet as a network of networks

The Internet as a platform offers different possibilities for communication such as Electronic Mail (e-mail), Internet Relay Chat (IRC), Telnet and File Transfer Protocol (FTP). However, the most widely used part of the Internet is the World Wide Web (abbreviated "WWW"). Although all these techniques are useful and may be needed in some planning situation, the proposed PIS attempts to simplify the requirements on the end users. It attempts to minimize the technical overload for planners and other participating actors, so that their main focus should be on the planning process and not on the planning information systems that support it. Therefore, the main emphasis was devoted to minimizing the technical requirements on the end-user; hence, for the majority of functions of PIS the WWW will be the technical environment.

5.3.3. The World Wide Web (WWW)

The World Wide Web is defined as "the universe of network-accessible information, an embodiment of human knowledge" (The World Wide Web Consortium, W3C). Its outstanding feature is hypertext, which allows the instant cross-referencing between different information resources in the web. The WWW consists mainly of two types of computers. On one hand, there are servers i.e. computers that include web pages and serve it upon request. On the other hand, there are clients i.e. programs installed by the end user to communicate with the Internet usually know as browsers. Between these two components, there is the network infrastructure that connects all these computers together.

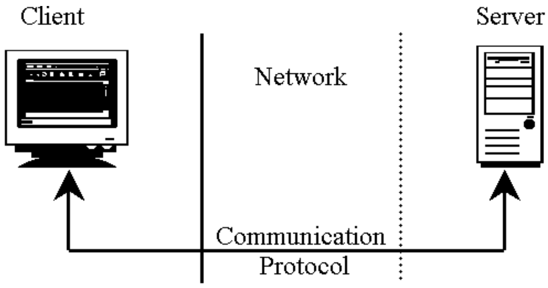


Fig. 5-3 Server – Client Architecture

Communication between clients and servers could be described in the mechanism:

- Authors of web pages publish it on a server,
- If a user wants to browse a specific web page, he should type the address of the Web Page (URL) in the address box of his browser, or just click the link if the page is linked from a different web page.
- The browser sends the query to the web server where the web page was published
- The web server processes the query and sends the response to the client
- The web browser interprets the web page on the screen

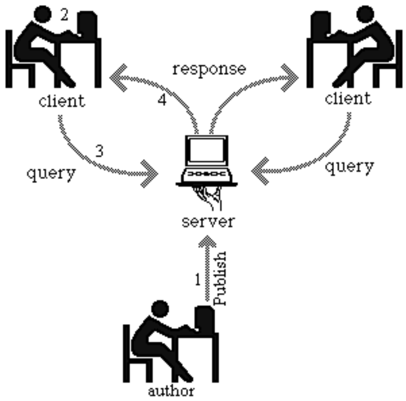


Fig. 5-4 the mechanism of WWW

5.3.4. Hypertext and Hypermedia:

The outstanding feature of the World Wide Web is the use of "Hypertext". The first half of the term, "Hypertext" - *hyper* - is used by many scientists and mathematicians to describe "extended" (Fraase 1989, in Schiffer 1992). The term "Hypertext" was first used by Ted Nelson* around 1965. He explains the term as a body of written or graphic material interconnected in such a complex way that it could not conveniently be presented or represented on paper (Ted Nelson).

The concept of Hypertext is based on the idea of using nodes inside a body of text. These nodes are called "hyperlinks". These links can reference and relate different parts of the same document as well as between different documents. These links allow a non-linear organization of pieces of information in an associative manner and constitute a networked structure (Streitz, 1992). Shortly, "Hypertext" is the organization of information units into connected associations that a user can choose to make. (whatis.com, 2000).

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* Ted Nilson is the inventor of Xanadu system which is a set of ideas and a software design project for a universal system of electronic information storage and access. He is credited with inventing the term Hypertext, an idea that is a central part of Xanadu. Conceived in the early 1980's or perhaps slightly earlier, Xanadu in some ways seems to have anticipated the Web and such ideas as groupware, group writing, virtual Organisation, and information . (whatis.com, 24.8.2000)

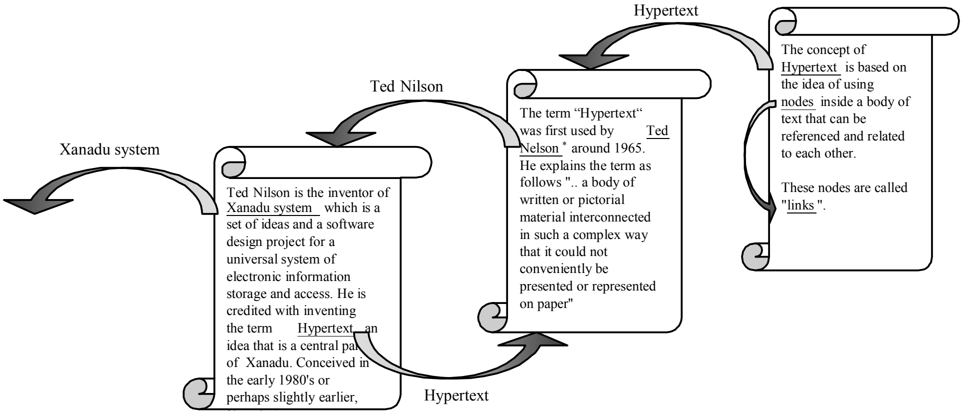


Fig. 5-5 The concept of Hypertext

Hypertext consists of two main components. The first is the units of information "the documents" which will be linked. The second is the links that relate these documents.

In addition, the Web does not only support hypertext, but also it supports different types of media in the form of hypermedia. Media as a general term is commonly used to describe methods of information presentation e.g. objects, complex graphics, pictures, video, audio, virtual reality or animation. (Shiffer 1992) Hypermedia, as a term, is derived from hypertext. If the nodes contain or relate to multimedia contents, the organization of information will be considered hypermedia rather than hypertext (whatis.com 2000).

It is important to draw a distinction between hypermedia and "multimedia" at this point. On one hand, multimedia is simply the technological basis to display different media types, e.g. showing video, editing audio, etc. On the other hand, hypermedia is the organizational structure behind the information. In other words, hypermedia is the method of organizing information of different media in an associative manner, while multimedia does not have any underlying organizational structure per se. (Shiffer 1992)

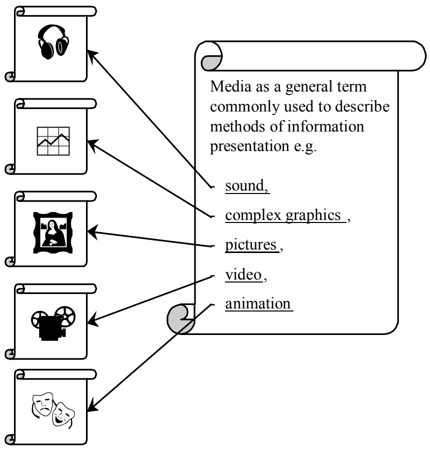


Fig. 5-6 The concept of Hypermedia

Why Hypertext and Hypermedia are used as bases for PIS?

The concept of hypertext is based on organizing and displaying associated information in a manner that facilitates the non-sequential retrieval of information. As related pieces of information are connected by links, users would be able to follow associative trails across the collection of information in the sequence and the level of details that is best suited to their needs (Encyclopedia.com). Furthermore, hypermedia technology facilitates combining different information formats into an arrangement that allows the fast cross-referencing of various concepts or issues. Thus, a variety of subject-related information, such as maps, texts, statistics, graphics, videos and news articles can be organized in an association. (Shiffer 1992)

5.3.5. Hyper Text Markup Language (HTML)

H-T-M-L is an abbreviation that stands for Hyper Text Markup Language. It is the major language of the Internet's World Wide Web. Web Sites and Web Pages are written in HTML. It is used as a platform for an open system that could be extended to connect with other types of Internet techniques that might be used for specific areas or projects.

The mechanism of HTML (fig. 5.7)

- ❶ The user requests a web page or a media file from a server either by typing the address of the page or by clicking a hyperlink in a page in his browser.
- ❷ The browser interprets the selection and makes request from an appropriate server
- ❸ The server accepts the request from the browser and checks if the requested resource or page is available and if the user has access to it.
- ❹ The server sends the requested media and text to the browser to be interpreted.
- ❺ The user sees the requested web page or the requested media.

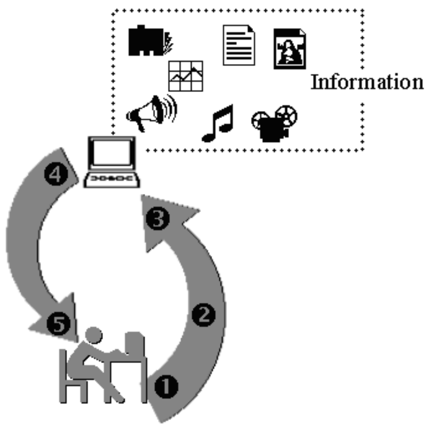


Fig. 5-7 The mechanism of HTML

Structure of HTML files

As HTML is the language of the Internet, which is the medium for implementation of PIS, it is essential to discuss it briefly. HTML files are plain-text files, so they can be edited on any type of computers e.g. PC, Mac or UNIX. HTML is a markup language but not a programming language that could be used for writing applications. HTML is just a set of markup symbols or codes inserted in a file intended for display on a World Wide Web browser page. The markup tells the Web browser how to display a Web page's content (words; images; etc.) for the user. Each individual markup code is referred to as a tag. It only aims at representing content and not triggering commands. Here below is an example of HTML file. To the left is the source code and to the right is how this code is displayed in the browser. (Fig. 5.8)

- ❶ A HTML file starts with the tag <html> and ends <\html>. This pair of tags tells the browser that the current file uses HTML as a language. Structurally, a HTML file consists of two main parts, the head and the body.
- ❷ The head includes elements that should not be viewed in the browser but it includes Meta information about the document and in some cases, it includes scripts and styles.
- ❸ The body includes the content that should be presented to the user.
- ❹ The head includes such tags as <title>, which tells the browser the title of the page. The browser interprets this tag and presents the title in the right position at the top of the browser's window.
- ❺ The body includes tags that are used for representation of the content. Each tag accepts a specific set of attributes that controls the representation of the content inside the opening and the closing tag.

It is important to note here that media and text files are processed

Fig. 5-8 Basic structure of an HTML file

Using pure html means that the user will get the content of the web page from the server without changing the content of the page. The client's browser parses the HTML code and converts it to plain text or images. The user can then click on a hyperlink to call the media file or the web page linked to it. Other than the hyperlink, the user will have no other interactivity with the web page as far as its content is pure html. Another limitation of HTML is the absence of positioning in the form of overlaying a specific element over another or positioning it at a specific location.

5.3.6. Dynamic generation of web content

As mentioned-above, pure HTML gives no interactivity beyond hyperlinks, which consequently limits the use of web pages for applications that need rich interactivity or dynamic structure of content. To enable dynamic generation of web content, two approaches could be adopted: a) server-side b) client-side. Server side dynamic generation of web content takes place on the server as result of a specific request from the client before sending the content to the client. Client side dynamic control of web content occurs after receiving the web page from the server. However, dynamic preparation of content on the server does not essentially mean that interactivity will be available on the client and vice versa. Technically, both of these two concepts represent potential bases for the development of PIS.

Dynamic generation of web content on the server allows users to define what they need from a large amount of information without needing to go through the whole information. For example, a user can select specific elements of a database according to some search criteria of his selection, or to select how the information should be represented e.g. in a table or in a graph. One of the applications of these techniques is Active Server Page (ASP). ASP pages are HTML pages that include one or more scripts (small embedded programs) that are processed on a Web server before the page is sent to the user. An ASP page involves programs that run on the server, usually tailoring a page for the user. Typically, server-side scripts in a Web page use the user's input or request to build or to customize the page on the fly before sending it to the client. Dynamic generation of web content could be extended by integrating a database that includes structured information. In this case, the whole application runs on Active Server Pages (ASP) environment, which runs most of the operations on the server and sends standard HTML to the client.

Client side dynamic web pages allow the representation of content in a dynamic manner including interactivity in the form of controlling visibility, representation and positioning of the page content without the need for a further requests from the server. These techniques allow for example, overlaying of different layers of information above one another and then controlling the visibility, the content or the position of these layers. This could be achieved using Dynamic Hyper Text Markup Language (Dynamic HTML or DHTML), which technically could be explained as a combination of HTML, cascading style sheets – a technique for the positioning and the representation of HTML content - and scripts - small programs written in a scripting language e.g. JavaScript. It will be then possible, using DHTML, to control positioning and layering possibilities of HTML elements in a web page and then to change styles, positions or the visibility of its contents using scripts. The main difference in the mechanism of DHTML from that of the HTML mentioned above is the possibility to interact with the web page through the web client after parsing its content without needing to make new request from the server.

Combining the flexibility of hypermedia as a representation medium with concepts such as hierarchy, modularity and association, will allow organizing planning information in ways that consider the characteristics of planning processes that are essentially non-linear, and the characteristics of planning information. It should facilitate innovative ways for capturing, organizing, representing, restructuring and summarizing planning information. For example, planners would be able to browse the information according to their needs, in more details when it is needed or in an abstract manner when it is enough. In addition, using the concept of modular structure will make it possible to use the same piece of information in different contexts and representations. Using the concept of association will make it possible to give the user higher interactivity with the information he is using.

However, in using this flexibility, it is essential to consider that too much interactivity and association lead to losing the concentration. Parts of the information should be static with no interactivity where the user should concentrate on the presented information with no distraction i.e. passive parts. On the contrary, association with further information or interactivity is needed when it adds value to the subject in the form of feedback or links with other pieces of information i.e. active parts. Such interaction would be 'intelligent' and 'enlightened' when it avoids distracting the user with unwished messages. It is important, to define which parts should be passive and which ones should be active.

It is important to mention that this technical general concept fulfils one of the predefined criteria of PIS in which any user could access the platform by using only a standard web browser. Therefore, the Internet and its innovative techniques are used as the base for the proposed system, as they fulfill each of the above-mentioned criteria. However, in using the Internet, the following criteria are considered to be important:

- using standard markup and scripting languages,
- keeping a cross browser platform,
- no use of specific programs. For example, the database could be established using almost any standard database application, the scripts could be written using any scripting language, and could be generated using standard applications (WordPad for example),
- the use of specific programs that need plug-ins should be limited if not completely avoided in the platform.

5.4. Realization of the proposed structure of PIS from a technical viewpoint

From the technical viewpoint the four structural components of a PIS, i.e. planning information, functions, the rules scheme and the user interface, are also dealt with in a modular manner. The following figure (Fig. 5.9) illustrates these four components, their interrelations and sub-components.

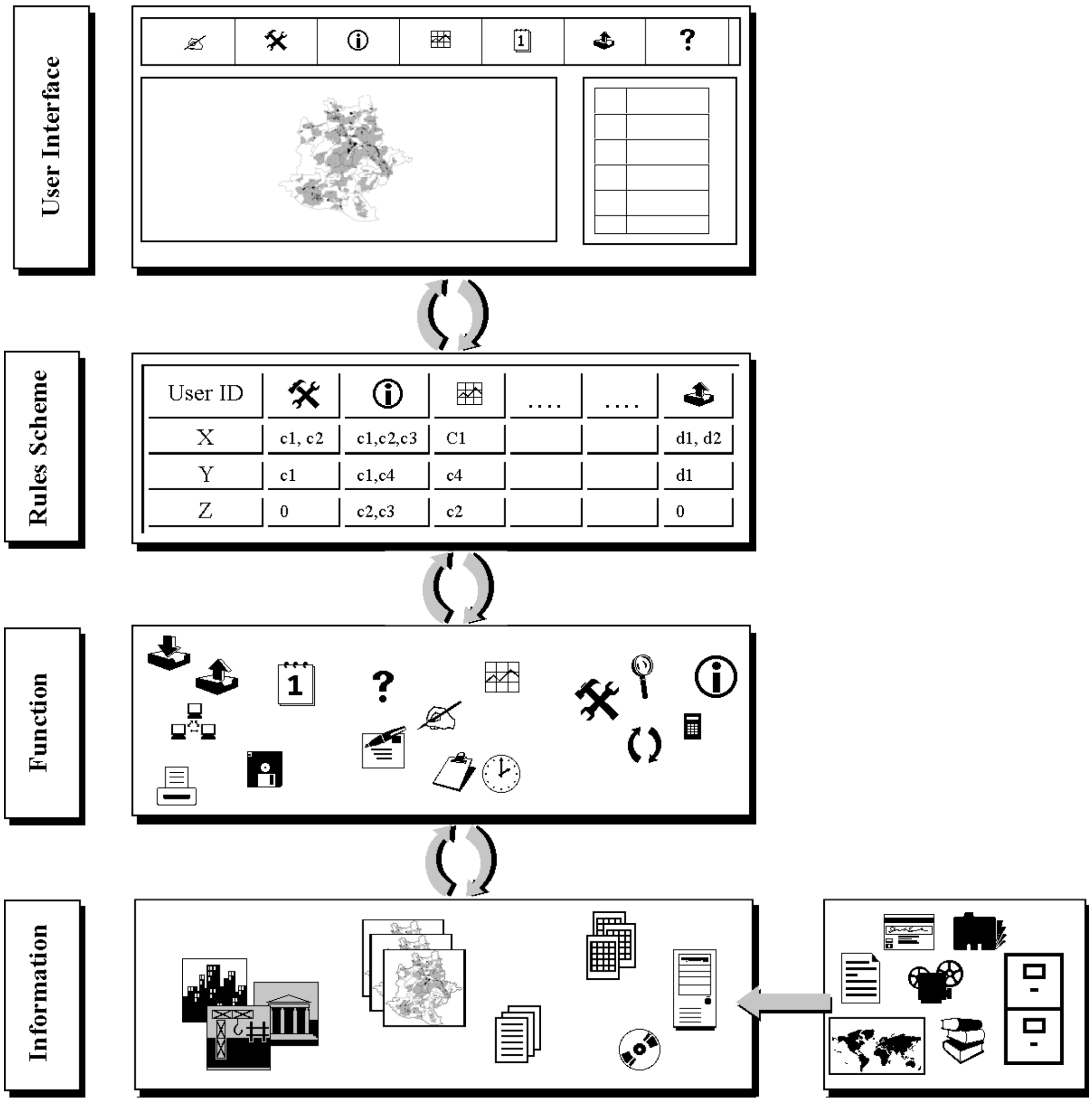


Fig. 5-9 Structure of PIS from a technical viewpoint

The diagram is read from bottom up. Different types of planning information are saved either in a database or as documents of different media types. The functions are a set of tools to facilitate information manipulation, file and media management, analysis and simulation, etc. The rules scheme includes declaration rules and the access rights. The user interface is the area where the user can use the functions and tools to process the information. Each of these components will be discussed from the technical viewpoint to define the specific technical requirements for each component. Then to define which techniques could be used to fulfill these requirements?

5.4.1. The information space

Topological, five different types of information could be identified. The importance of distinguishing these five types emerges from the various requirements that are needed for each one of them. The three types are:

- primary information objects that deal with information that could be organized in one or more databases,
- documents of different media types,
- Meta information about information that is not directly accessible in the system but available elsewhere,
- graphical information objects that include different layers of graphics and layer sets,
- logical information objects that represent a logical relation between different pieces of information to produce secondary information.

a. Structured information

Information that could be classified into classes of objects is dealt with as structured information.

- Each class is described using a set of attributes and relations. The first step in developing a PIS is the definition of the set of classes that are needed or should be processed in the system. The concept of object classes could be applied to a variety of objects in the three information domains in spatial planning. In the subject matter domain, “PROJECT”, “PROBLEM” and “POTENTIAL AREA” represent some examples of classes of information objects. In the process domain, “ACTOR”, “EVENT”, “DECISION”, and “MESSAGE” are important classes of objects. In the planning knowledge domain “LITERATURE”, “ARTICLE”, and “LAW” are also some examples. All classes should be registered in a class registration table.
- Then, each class should be declared using a class declaration table that includes the set of attributes and relations that describes the instances of this class.
- The instances of each class are saved in a separate table in the database. The structure of each table is corresponding to the declaration of this class.

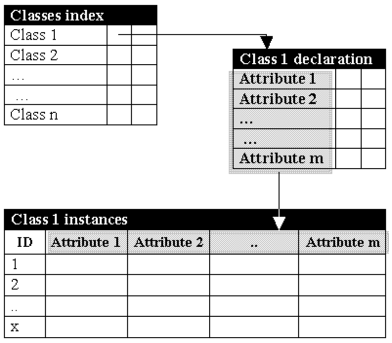


Fig. 5-10 classes declaration scheme

The class declaration table includes different fields that are used to define the attributes and relations for each class of objects.

- The field “Att. Name” includes the title of the attribute.
- The field “Att. Type” defines the type of the attribute e.g. String, Integer, Date, Boolean, etc.
- “Att. Multiplicity” defines the attribute multiplicity i.e. if this attribute accepts a single value or multiple values.
- “Value List” is the span of values for each attribute.
  - If “Att. Type” is “Relations“ the “Value List” should be “Member of” another class. For example for the class of objects “PROJECT” the attribute “located in” indicates a relation with the class of objects “DISTRICT”. In this case, the “value span” of this attribute is “Member Of ‘DISTRICT’”. This type is used to link different classes of objects.
  - If “Att. Type” is ‘List’, then the “Value List” should include all possible values of this attribute. Consequently, this attribute accepts only an option form the ‘Value List’ array, e.g. the attribute “subject” of the class “DOCUMENT” should be selected from a specific list of predefined subjects. This list could be extended if no logical restriction is apparent.
  - If the “Att. Type” is ‘Boolean”, the “Value List” might be a pair of values such as true/false, 1/0, yes/no, etc.
  - One of the important attributes for many objects that might be needed in spatial planning is the positioned object. Positioned objects, as any other class of objects, have different attributes according to the class. The main distinction of such a class of objects is their spatial reference. They are related to a specific location on the earth, which is needed to position them on maps. This class is important to facilitate the graphical representation of spatial elements that is needed for exploring planning contexts.
- The class declaration table contains other fields, e.g. ‘is Primary’ that defines if this attribute is obligatory or optional. The list of attributes could be changed according to the circumstances of the planning situation.

Class name = ‘CLASS X’				
ID	Att. Name	Att. Type	Att. Multiplicity	Value Span
1	Attribute 1	String	1	
2	Attribute 2	Relation	n	Member Of ‘CLASS Y’
3	Attribute 3	Date	1	Date
4	Attribute ..	List	1	Value 1, value 2, value 3, …., value m
5	Attribute ..	Boolean	1	True/False
n	Attribute n	Positioned element	1	xyz

Fig. 5-11 Basic classes definition table

For each class of objects a similar declaration table is needed. This process could be understood as the definition of the object language that should be used in the context of the planning process. It includes the primary elements of the language, the classes of objects, and the rules for using these objects, the class declaration.

It is important here to note that the object definition process, as described here and used in PIS, differs from the conventional information modeling process in a main aspect. Traditional information modeling is thought of as a comprehensive process that deals with well-structured information processes e.g. in routine tasks as in hospitals or libraries. On the contrary, the above-mentioned process is iterative and could be conducted at any phase of the lifetime of the system by adding new classes of objects, by modifying the list of attributes or by changing the value span of a specific attribute in this list.

This difference is essential due to the nature of planning information on one hand and to the explorative nature of planning processes on the other. Hence, none of these three tables should essentially be comprehensively complete at the beginning of the process. The declaration process as described here is relatively simple and requires no specialized knowledge other than the principal knowledge of database.

b. Documents

The content of many documents could be organized into different classes of objects. However, it is usual that a document would be used as a whole, even if large parts were organized in different classes. In PIS, documents are considered a class of information objects that have a special attribute relative to other classes of objects, namely that it has two components i.e. the document itself and the information about this document. Documents could have different types, sizes, subjects, sources, dates, etc. In addition, different documents might have different levels of accessibility. Hence, it is not enough to supply all documents just as fragments of information without any structure. The second component of the document is the document's attributes that are organized in the database.

Class name = 'DOCUMENT'				
ID	Att. Name	Att. Type	Att. Multiplicity	Value Span
1	Title	String	1	
2	Author	Relation	n	Member Of 'AUTHOR'
3	Source	String	1	File Name
4	Date	Date	1	Date
5	Category	List	1	Protocol, memo, agenda, law, report, book, article,
6	Access State	List	1	Public, restricted, regulated
7	Document State	List	n	Draft, Version, Review, Final, Edition
8	Change State	Boolean		True/False
9	Related to Event	Relation	n	Member Of 'EVENT'
10	Part of Document	Relation	n	Member Of 'DOCUMENT'
11	Subject	List	n	Subject 1, Subject 2, Subject 3
12	…			

Fig. 5-12 Example of "DOCUMENT" classes definition table

Regarding the above-mentioned dual nature of this class, additional functions for document handling are needed in addition to the regular functions for handling structured information. Each document will be registered in a specific table in a databank with its attributes while the document itself will be available in a documents' folder. This dual structure facilitates accessing the documents in different contexts and users can have different access rights to the same documents.

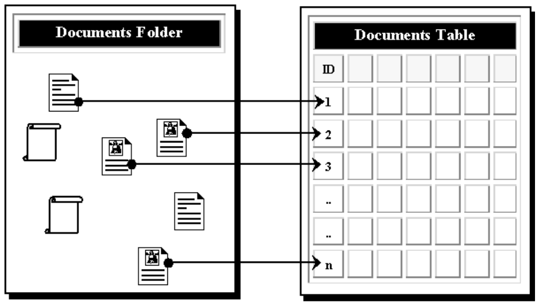


Fig. 5-13 The dual structure of the class 'DOCUMENT'

c. Information about information (Meta Information)

In addition to the above-mentioned two types of information, there are information resources that are not directly available in the system but are distributed over different information providers, libraries, organizations, actors, web sites, etc. Meta information about these resources is organized under different classes of objects such "LINK" which indicates an online resource that could be called on demand. In this case another attribute type will be used i.e. the "hyperlink" type that can be used to call distributed information resources. This type could be described as a virtual distributed library where documents of different media types are registered into the database, while the original material is stored in different places.

d. Graphical objects "LAYER" and "LAYER SET"

For dealing with graphics of different types, a specific class of objects is proposed to organize these graphics. This class is called here the "LAYER" class. The "LAYER" class is different from simple graphics in the following aspects:

- A set of layers could be grouped in a "LAYER SET", that allows overlaying these layers. These layers should have the same scale and the similar spatial context.
- Each layer might include a set of positioned objects from a different class of objects.
- Any layer set could be linked with a different layer set, for example to explore a specific context in more details.

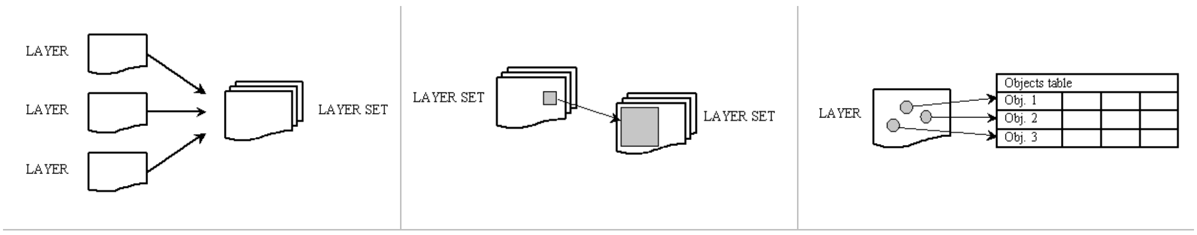
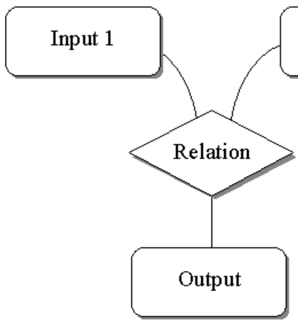


Fig. 5-14 Graphical objects "LAYER" and "LAYER SET"

For the object “LAYER SET”, a specific set of functions is needed for controlling the activity and visibility of layers.

e. Logical information objects:

A logical information object represents a logical relation between different parameters. Such relations are defined as objects that include a logical relation between the input values and the output values. For example, the “motorization rate” could be described as a logical object that resembles the relation between the “total number of population” and the “car ownership rate” in a specific city. Another example is the relation between the maximum allowed floor area ratio (FAR) in a specific district and the area of a specific lot that produces the maximum potential total floor area in this lot.



Logical object declaration	
Item	**Description**
Input 1	Unit
Input 2	Unit
...	..
...	..
Relation a	Input x, input y, logical relation

Fig. 5-15 Definition and declaration of logical information objects

5.4.2. The functions and the tools

For each of the earlier mentioned information types, different types of functions and tools are needed. By defining and classifying these functions and tools, it will be possible to define which functions and tools could be reused in the form of routines in different applications, which functions should be adjusted according to the specific requirements of the application and which functions should be developed specifically for each application.

For structured information in the form of classes, a set of functions could be defined as modules and reused in different applications such as:

- Primary functions for handling individual information objects by:
  - creation,
  - modification,
  - representation, and
  - destruction.
- Secondary functions for handling a set of information objects by:
  - Structuring and organization;
  - browsing,

* listing,
* searching, and
* sorting.

Regarding the second type – documents – there must be a tool for the publishing and the administration of documents.

- uploading,
- organization,
- manipulation,
- file management.

For the graphical objects a graphical interface should facilitate layer control, layer set control and positioned objects manipulation. This set of functions includes:

- map navigation,
- overlaying and layer control,
- map browser (zoom, pan functionality),
- visualization of search results on maps, and
- input of positioned elements.

For the logical objects (simulation), a function to declare the logical objects and to run different simulations is essential.

Furthermore, process-oriented functions are not limited to the primary processing of information. The set of functions includes but is not limited to the following functions:

- Statistical interface (statistical analysis)
- Argumentation and discussion
    * raise an issue,
    * browse existing issues,
    * declare a position or browse other positions to one of the issues, and
    * put an argument against or pro one of the existing positions or browse other arguments.
- Time line.
- Collaborative project office tool (coordination)

The tools and functions in PIS are either server-side or client-side scripts that are written using a scripting language such as JavaScript or visual basic. Each function and tool is considered a component that runs independently from other components. This modular organization of the functions facilitates reusing of the functions in different application. It also facilitates updating a specific function without changing other functions.

5.4.3. The rules scheme

The rules scheme is a set of rules that governs the whole system in the form of user rights, information control, functions control, etc. This scheme consists mainly of two groups of rules, namely declaration rules and access rules.

Declaration rules

The declaration rules are a set of rules that governs the declaration of different information objects including the definition of the attributes of the objects of each class. To define the attributes of a specific class of objects, at least the data types, the value span and the validity rules should be defined. That means if in a specific class of objects the value type of a specific attribute is defined as an 'integer' number, it should not be allowed to enter numbers with decimal places in this field. For example in the case study of NBS - NBS which will be discussed in details in chapter 6 - the part of the rules scheme concerning the value type of the field "area" in the class of objects "potentials" was loose enough to accept a string although it should only accept a number. Afterwards, it was obvious that the sorting and the mathematical operations are not possible for this field as many users entered textual information with the area. Hence, it should be clear that for such a field the rules scheme should be tight enough to ensure the proper functionality of the system. However, in tightening the rules scheme it should not form additional effort to the user. The rules scheme should by applied in a way that guides the user through the entry phase and validates his entries before processing them.

Access scheme

The access scheme is the set of rules that controls the access of different users to different functions and information in the system. The following figure (5.16) illustrates the matrix of access rights of different users. Each column is corresponding to a specific function e.g. add new, edit, delete. For each user a record in the access scheme represents his access rights. In each cell, the code is the identification of different classes of objects that are available for a specific user to apply a specific function. For example, user "X" has editing right for classes 'c1' and 'c2'. In addition to the earlier two classes, this user has an access right to view the class 'c3'. In other words, he has only the right to view available information in class 'c3' but not to change it. This could be the case regarding specialized information e.g. the city planner might be allowed to view environmental information but not to change it. This aspect will be covered in more details and with examples from the practice in the coming chapter. In most cases, a user who has access to all classes and to all functions is the system administrator. User "Y" has a specific area access and some limited functions. Such a user is normally an information supplier. User "Z" is an information consumer who is only allowed to view the information but has no right to edit or administrate it. In other words, he has a restricted access.

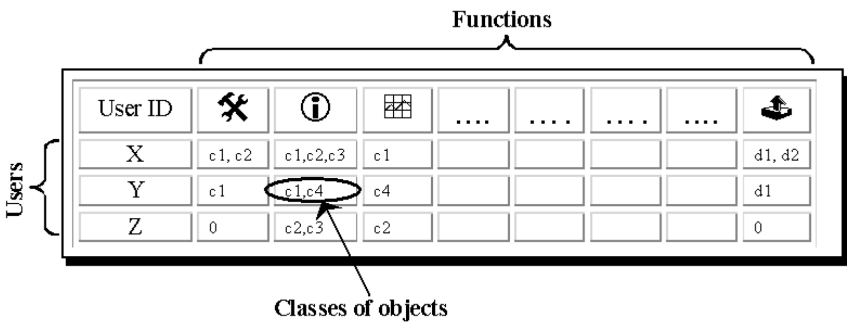


Fig. 5-16 Access scheme

5.4.4. The user interface

The user interface is the direct contact between the user and different components of the system. It facilitates the users' access to different functions and information through a graphical user-friendly environment. It should consider the user's access rights as defined in the rules scheme. Hence, it should be dynamically generated according to the access rights for different user groups or for individual users.

The user interface combines the functions that are permitted for each user according to his access rights, which are defined in the access rules scheme. In addition to the tool bar, the user interface includes a working area for browsing and manipulating different information elements and for viewing results of different processes. According to the system requirements, the user interface may include textual, tabular, graphical and geographical modes. The more the interface facilitates exploring the same information in different modes and in different contexts, the more advanced it is considered to be. This allows a better understanding of the subject matter of planning. It should also allow interactivity when further associations are available and needed. The graphical mode should facilitate the overlaying of different information layers to obtain the best approach to understand the context.

In addition, the user interface is the area where different users can browse and interact with the distributed information and maps from different sources of the participant agencies. The interface allows the user to overlay maps from different sources and to produce the map that fits his purpose. The user can also search in these distributed databases simultaneously using different criteria and extract information about the matching elements. To reach such integration among different sources of information, common standards are essential. Similarly, to reach such standards, collaborative work between different participating actors is needed.

The user interface (UI) has two functions. First, it gives the user the access to all the possible functions according to his rights. Second, it is a visual environment to present the results of user's queries and requests. This UI is also a combination of ASP, scripts and HTML or Dynamic HTML. This UI should be graphical and user-oriented.

6. Application Case Studies of PIS

The concept and the framework of PIS as discussed in the preceding chapters are the results of several experiments and projects that represent different cycles of conceptualization, implementation, evaluation and enhancement. This chapter aims at demonstrating the application of the proposed concept of PIS in different cases. Each of these cases represents a different phase of developing the proposed concept. The results and experiences collected in each case have contributed to the improvement of the framework from the conceptual, the technical and the operative perspectives.

The four case studies that are represented here below demonstrate the application of PIS in different planning levels.

- The case of “Südbahn” deals with a project on the national level in Austria.
- The case of “SGMC“ (Sustainable Growth Management in Cairo) is developed for the regional level of Greater Cairo Region.
- The project of “NBS” (Nachhaltiges Bauflächenmanagement Stuttgart) covers the city level in Stuttgart.
- The case of “NST” (North-south Trans European railway corridor) is a proposal on a trans-national level of different European countries.

These cases deal with a variety of planning situations and subjects. The cases of “Südbahn” and “NST” deal with the impact of the large scale infrastructure development on spatial development while the cases of “NBS” and “SGMC” deal with the subject of sustainable growth management in rapidly growing cities and regions. None of these cases could be dealt with as a routine task regarding the integrated dimensions of complexity and interconnectivity as well as the internal and external dynamics that govern the situation. These complexities could be classified into a) organizational complexity, b) subject-related or physical complexity and c) information-related complexity.

Organizational complexity might result from cross-organization or cross-border cooperation among a large number of actors that are not used to cooperate. Subject-related or physical complexity might result from the interconnectivity among different levels of planning or from the interconnectivities between different problems and subjects. It might result also from legal or time-related limitations. Complexity related to information might result from distributed knowledge or from rapidly changing information. It results also from sharing information from different sources with different standards and qualities. From a different perspective, PIS in each of these cases covers different areas of the afore-mentioned information domains i.e. the subject matter domain, the process domain or the planning knowledge domain.

As mentioned earlier, the design, development and implementation of a planning information system should consider a) the characteristics of the spatial problem that presents the subject of planning, b) the characteristics of the planning process in which this subject is handled and c) the planning information that is needed, processed or produced in the process of problem solving or conflict resolution. Hence, each of these case studies starts by introducing the background of the case regarding these three aspects: the subject, the process and the information. Based on these aspects, the need for a planning information system will be discussed to illustrate the goal and the tasks of the proposed system and to define the information processes that should be supported. Consequently, the main development and implementation criteria will be introduced according to these aspects. Then, the proposed system will be discussed to illustrate the main components of the system including the information structure, the functions and the tools, the rules scheme and the user interface. Afterwards, the implementation of the systems will be discussed.

6.1. The Southern Railway System in Austria (Südbahn)

6.1.1. Background

The subject matter: The Austrian federal ministry for science and transportation has set an ad-hoc group of experts and officials to evaluate the upgrading alternatives for the southern railway system*. The task of this group is to identify an efficient connection between Vienna and the southern parts of Austria through the Alps considering the technical and economic aspects as well as the operative efficiency of the transportation system.

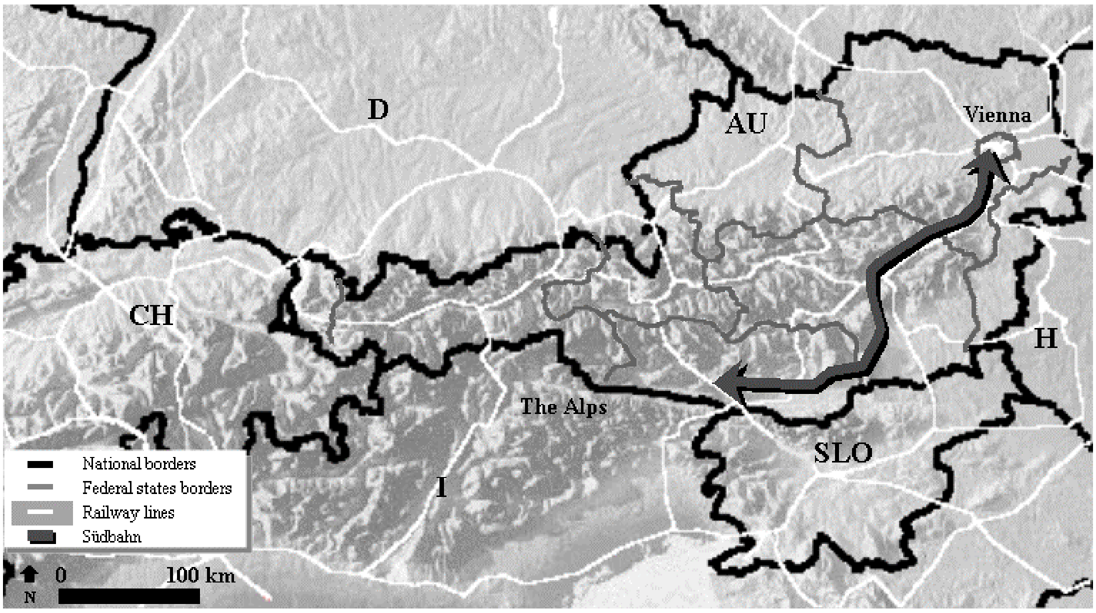


Fig. 6-1 The Südbahn should connect the southern states in Austrian with Vienna through the Alps

Participating actors: The group consisted of independent experts for spatial planning and transportation planning as well as representatives of the federal states: Vienna, Niederöstrreich, Steiermark and Kärnten. The participating experts are from Austria, Germany and Switzerland.

The time frame: The work of this group extended over two years (1998-2000). However, the development and the implementation of the proposed PIS took place between June and October 2000.

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* Die Experten-Arbeitsgruppe für „Ausbauvarianten des Systems Südbahn“

6.1.2. Characteristics of the situation:

Regarding the subject matter of this case, the Südbahn railway system has a multi-dimensional interconnectivity with different spatial activities on different levels including the European, the Federal level in Austria and the regional level. Here below some examples of interconnectivity are listed:

- On the European level, the project is related to other European projects such as the Trans European Network that connects the member countries of the European union, and the Pan European Network that connects the European union with the eastern parts of Europe. (These networks will be described in more details in the case study of NST later in this chapter)
- On the federal level of Austria, the Südbahn should connect the southern states of Austria with Vienna through the Alps. This direct connection plays important political and economic roles on the federal level.
- On the interregional level, different alternatives would bring different positive and negative impacts for different regions. For example, an alternative that represents the optimum solution from the viewpoint of a specific region does not represent the same thing for another.
- On the bi-national level between Austria and its neighbors such as Hungary, some solution alternatives could be realized by integrating some existing and planned infrastructures on the border region between Austria and Hungary, on the Hungarian territories.

Regarding the planning process, different characteristics play an important role in developing the proposed PIS such as:

- The participating actors are from different countries and different regions.
- They are from different backgrounds and have different interests.
- They meet periodically once each quarter.

It was apparent that dealing with the system as a whole is neither reasonable nor efficient. Therefore, the system is organized into different modules. This modular structure is essential for several reasons:

- Some modules are agreed upon while others have fewer consensuses.
- Some modules require further research regarding the number of possible solution alternatives while others are relatively clear.
- For different modules, different actors are involved in the planning process or different actors are affected by the development of the project.
- The implementation of the whole system could not be conducted in one phase; the whole development is estimated to take between 15 to 20 years. In each phase of development, the system should be operating efficiently.

1	Wien - Wampersdorf
2	Wampersdorf - Wiener Neustadt
3	Wiener Nneustadt - Gloggnitz
4	Gloggnitz - Muerzzuschlag
5	Muerzzuschlag - Bruck a.d. Mur
6	Bruck a.d. Mur - Klagenfurt
7	Klagenfurt - Villach
8	Klagenfurt - Graz
9	Graz - Szombathely
10	Graz - Bruck a.d. Mur
11	Aspangbahn
12	Szombathely - Sopron
13	Sopron - Wampersdorf

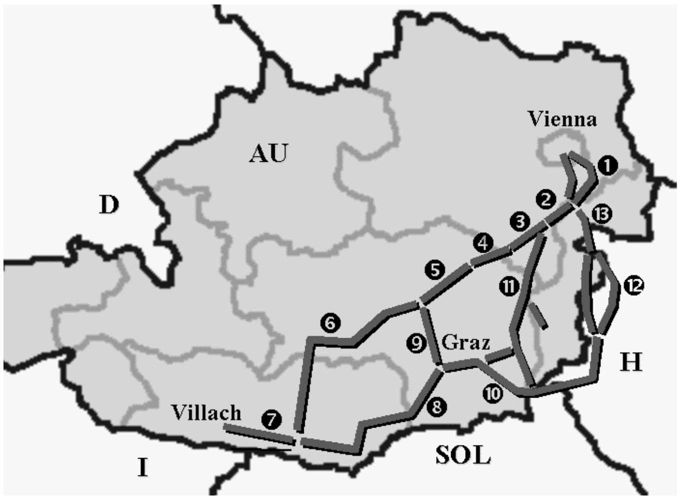


Fig. 6-2 The modular structure of the Südbahn system

After several months of work, a huge number of documents were circulated, produced or used in the process. These documents are related to the process domain or to the subject matter domains. They include different types of documents that range from feasibility studies to organizational correspondences. The above-mentioned modular structure represents a basic classification criterion that facilitates structuring these documents. Each of these documents is related to different modules of the system. From an organizational point of view, these documents are related to different sessions of the expert group.

6.1.3. Application of PIS

The need for a PIS: It was apparent that, a system to structure and organize these documents was essentially needed. This system should facilitate organizing, structuring and recalling these documents. In addition, the system should facilitate creating an overview about the different modules of the project based on the content of these documents. As an initiative from the chairman of ISL*, who was a member of this expert group, a system was developed and implemented to support structuring and organizing the above-mentioned documents.

Development criteria: From the criteria matrix shown in table 6.1., the following points represent the main development criteria of PIS in this case:

- The actual lifetime of the system is limited to the lifetime of the process. This could be attributed to the fact that the main goal of the system is to facilitate managing the documents throughout the remaining time of the process.

* Prof. B. Scholl the chairman of Institute of Urban and Regional Planning in the university of Karlsruhe,

- There is no essential information exchange with other information systems. However, the system should be based on a standard format that could be exchanged with other systems.
- The information is supplied centrally. There is no need for file management functions.
- The distributed access to the information is a pre-requirement. It should be available from any computer connected to the Internet, but the access is password protected.
- The system structure in this case is relatively flat. It deals with a core class of objects i.e. the “DOCUMENT” class. Other classes are only used to classify this core class.

Criteria	Degree							
	Min.		←				→	Max.
Time span	Short		✔					Long
Open to other Info. Sys.	Closed		✔					Open
# of users	Low		✔					High
The information								
Distribution of Supply	Central		✔					Distributed
Distribution of Access	Limited						✔	Distributed
# of classes of objects	Limited		✔					Large
Dynamism of content	Static		✔					Dynamic
Types of media	Alphanumeric		✔					Multimedia
The rules scheme								
Differentiation of users	Low	✔						High
The functions								
Database							✔	
Documents			✔					
Argumentation					✔			

Table 6-1 Südbahn PIS development criteria matrix

- Regarding the media types that should be included in the system, only alphanumeric information about the documents is expected in the database. In addition, different types of documents, that are digitally available, should be included in the system.
- Regarding the experimental nature of the system, the number of users is limited.
- In respect to the rules scheme, there is no need to classify the users according to their access rights. Consequently, the user interface is similar for all the users.

The information space: The main class of information objects in this case is the “DOCUMENT” class. Most of the primary attributes of this class, as mentioned in chapter 5, are needed. In addition, several specific relations are required to describe the relation between this class with other secondary classes of objects such as the class of “MODULES” and the class of “SESSIONS”. These secondary classes of objects are used only to facilitate the classification of the documents using different criteria to allow exploring the documents in different contexts e.g. temporal, spatial, content, relevance, etc.

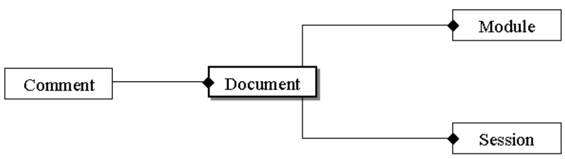


Fig. 6-3 Main classes of information objects in the information system of the Südbahn

The relation with the class of "MODULES" is a basic classification criterion for the spatial overview (fig. 6.4.d). Each document might have a multiple relation with one or more of the 13 modules. This facilitates grouping the documents that are related to a specific module to allow comparing and combining their content.

The second important relation is the relation with the class "SESSION". Most of the documents are related to a specific session of the expert group. From organizational viewpoint, this classification facilitates following up the process.

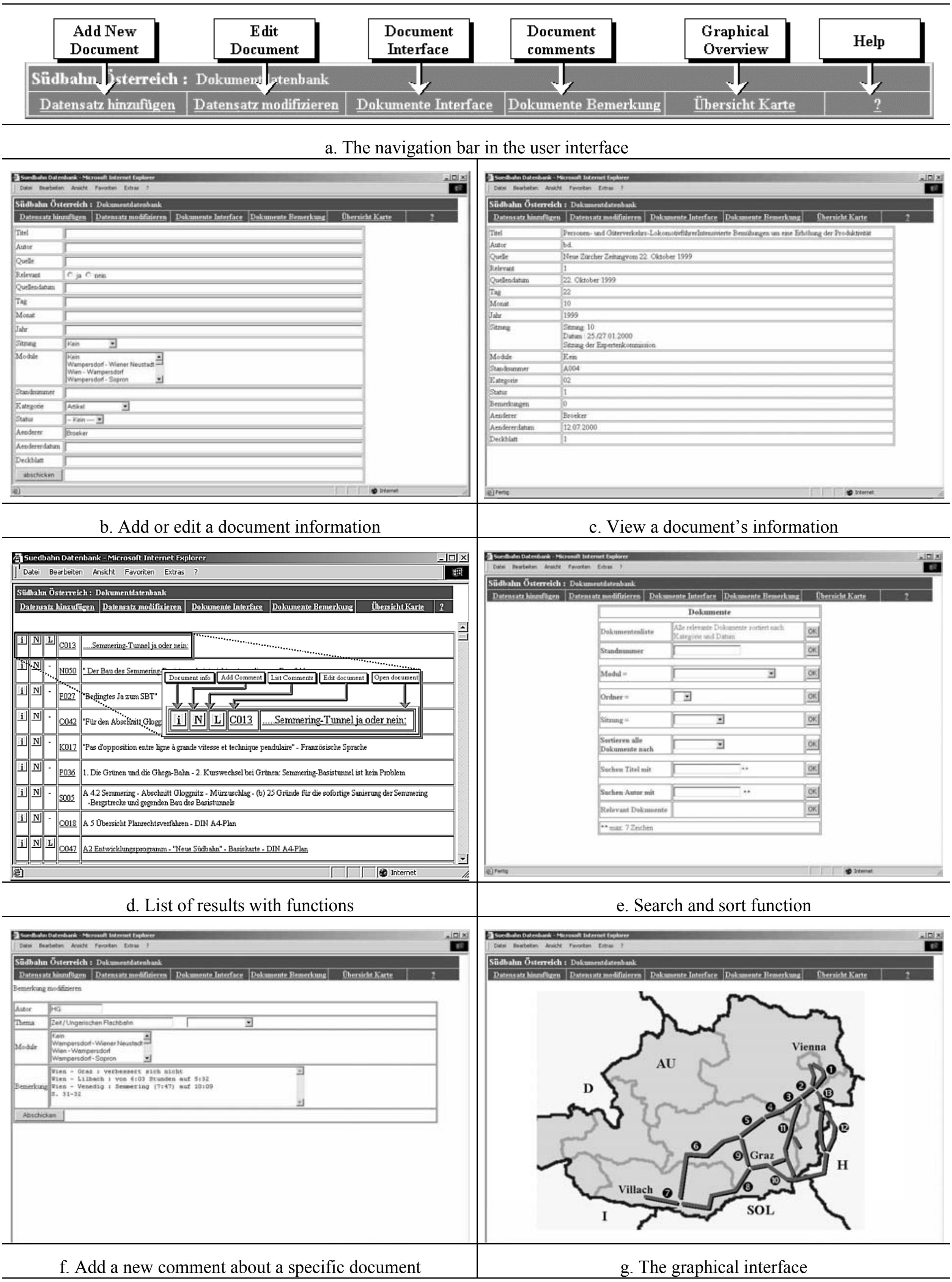
Class name = '**DOCUMENT'**				
ID	**Att. Name**	**Att. Type**	**Att. Multiplicity**	**Value Span**
1	Title	String	1	
2	Author	String	n	
3	Source	String	1	File Name
4	Date	Date	1	Date
5	Modules	Relation	n	Member Of 'MODULES'
6	Session	Relation	1	Member Of 'SESSION'
7	Document Type	List	n	Report, Invitation, Agenda, Protocol, etc.
8	Relevance State	Boolean		Relevant/Irrelevant

Another class of objects is introduced in this system, namely the class of "COMMENT". This class is designed to facilitate discussion about the content of the different documents. Each "COMMENT" is related to a specific "DOCUMENT" as shown in fig. 6.3.

The functions and the tools: using the classification of functions that is introduced in section 5.4.2., the functions in this case are grouped as following:

- Primary functions are related to database management such as adding new records, editing or viewing the existing ones (fig. 6.4.b. & fig. 6.4.c.)
- Secondary functions include tools for listing all available information records (fig. 6.4.d). Additionally, the system allowed text oriented search and sorting functions using different criteria (fig. 8.4.e). The matching records for each of these functions are represented in the form of a list accompanied with functionalities for browsing the document information, editing it or browsing the document itself if it is available in a digital form.
- In addition, the possibility to add comments to a specific document was available as well as the possibility to view available comments for a specific document.
- By using a graphical interface in the form of an overview map about the different modules of the project, it is possible to browse the documents in their spatial context (fig 6.4.g). By clicking on any module on the map, all relevant documents that are related to this module will be listed with functions to open or to edit the information that is related to this document.

The rules scheme: In this case the whole system is password protected, but the authorized users are not differentiated by access rights. This could be attributed to the small number of authorized users and the experimental nature of this case.



a. The navigation bar in the user interface

b. Add or edit a document information

c. View a document's information

d. List of results with functions

e. Search and sort function

f. Add a new comment about a specific document

g. The graphical interface

Fig. 6-4 Different functions in the user interface of the PIS in the case study of "Südbahn"

The user interface: The user interface is a web page that includes two main parts. At the top is the navigation bar figure 6.4.a. The rest of the page includes the information area where the results of different operations are displayed or further navigation tools are represented according to the selected functions. Figure 6.4. illustrates different components of the user interface.

Technical aspects of the proposed PIS: An Internet based system is proposed to fulfill these criteria and to conduct the planned task. The proposed system used different standard Internet related techniques. At the back end, the information was saved in a database (Microsoft access 2000). The whole application runs in an ASP environment (Active Server Page) using JavaScript as a scripting language. For any user to access the system, he needs only an Internet access and a standard Internet browser. Using his Internet browser, the user can conduct all the available functions with no need for further programs.

6.1.4. Concluding remarks

- This case study represents a planning subject on a sub-national or trans-regional level. It deals with a large-scale railway infrastructure project. The participating actors in the planning process were from different regions and different organizations.
- The application of PIS in this case is limited to supporting the organization of the available documents and facilitating access. These documents covered the three domains of information in spatial planning. The PIS in this case, included documents about the subject matter, the process, the background and the solution directions.
- It is important to mention, that the application of the concept of PIS in this case study is one of the early experiments that are conducted by the author to explore the technical and conceptual aspects of the proposed PIS.
- By the end of the process, the system included information about more than 500 documents of different types. The system allowed accessing the information, independent of time and place. It also allowed accessing these documents in different contexts. The system allowed decentralized management of the documents and the information.
- The development process took an explorative and iterative nature in form of several cycles of development, implementation, evaluations and improvement. After each phase of development, the feedback from the end users was collected in personal conversations. Then, the needed improvement in the form of functionality or enhancements was integrated.
- By critically observing the system implementation, the following aspects are important for the further development of such systems:
  - Although the "DOCUMENT" class is regarded in this case as the main class of information objects, other classes of objects could have been fully included with a minimum effort such as the "SESSION" class and the "MODULE" class. Both of these classes of objects are only considered as classification criteria with no further information.

* By extending these two classes of objects, it could have been possible to implement further information functions such as cost, realization phases and travel time of different combinations of modules. On the organizational level, it could have been possible to coordinate the sessions and the relevant organizational information to minimize the organizational effort.
* It was also evident that remote file management functions are needed to facilitate remote control of the system content.
* The simple search form using single criteria at a time was not enough. Multi criteria search is needed in such systems to allow efficient combination of search results.
* The use of the discussion tool was very limited. It was mainly oriented to make important citations from the documents. This minimal use of the argumentation tool could be attributed to the experimental nature of the case with a small number of users. It was more efficient to discuss the comments in personal meetings.
* Access to the system should be classified according to the user's right. The flat organization of the access rights, even in a limited process, proved to be a restriction. For example, it was not possible using this flat organization to allow a guest user to view the information without having the right to change it.

6.2. Sustainable Growth Management in Cairo (SGMC)

6.2.1. Background

Location: Greater Cairo Region (GCR), Egypt.

The subject matter:

This case is an attempt to explore the potentials, the limitations and the requirements that should be considered in developing a planning information system for supporting sustainable growth management in a third world metropolitan area under rapid growth dynamics.

Participating actors:

This case study deals with an experiment that was conducted by the author.

The time frame:

This case study has started at April 1999. A paper about the early ideas of this case study was published in CORP 2000 in Vienna under the title "Internet Based Planning Information Systems as a Supporting Tool for Urban Planning Process." in the symposium "Computergestützte Raumplanung, 5. Symposium zur Rolle der Informationstechnologie in der Raumplanung", Vienna, 2000. The conceptual and technical framework of the case was further developed and improved until December 2000.

6.2.2. Characteristics of the situation

Three major aspects govern the development and the implementation of PIS in the case of sustainable growth management in Cairo, namely characteristics of the spatial situation, characteristics of the planning process that is needed to deal with this problem and characteristics of the planning information that is needed to explore and to solve the problem.

Regarding the spatial context, three main interconnected aspects are discussed here below, namely: the demographic and urban growth dynamics, the physical restrictions and infrastructure development. Regarding the planning process, the jurisdictional partitioning and the legal framework of urban planning and urban development in Cairo are introduced. Then the main characteristics of planning information in this situation will be briefly discussed.

Growth dynamics in GCR

The urban agglomeration of Cairo is considered one of the largest populated human settlements in the world. In 1996, Cairo was number 17 of the largest cities regarding population size. It is estimated that Cairo will be number 14 in 2015.

At the beginning of the 19th century, the population of Cairo metropolitan area was 0,3 million. Until the beginning of the 20th century, it has doubled to be 0.6 in 1900. After that, it needed only thirty years to double again to be 1,2 million by 1930. In the interwar years, it continued its rapid growth reaching 2 million by the outbreak of the World War II. By 1970, Cairo population has reached 5 million inhabitants (Yousry & Aboul Atta 1996). This demographic increase was accompanied by a considerable urban growth. The agglomeration area of Cairo has more than tripled from 100 sq. km in 1950 to 350 sq. km in 1970. However, this increase in the urban area was not as fast as the population increase, in some old districts of Cairo the population density has reached 136,000 inhabitants km^2. The extraordinary population explosion after 1950 could be attributed to the development policy that was adopted by the revolutionary government after 1952. The government has undertaken substantial industrial and housing projects. A considerable amount of these development activities was concentrated in the Cairo region leading to the attraction of more migrants from different parts of Egypt searching for better life.

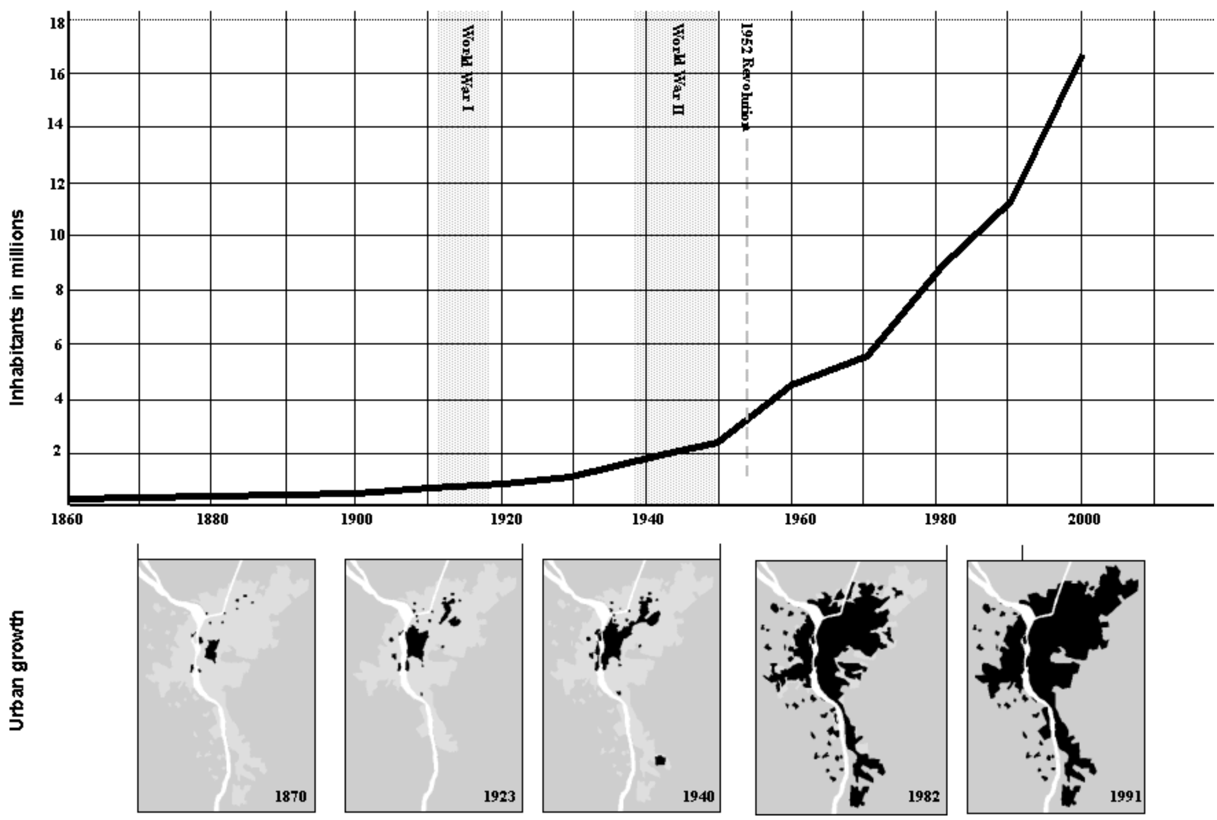


Fig. 6-5. Demographic and urban growth in GCR since 1870

After 1973, the policy of economic liberalization has replaced the socialist system encouraging private, international and Arab investment. A large part of these investments was concentrated in Cairo fostering further rapid urban growth leading to the consumption of more land on one hand and attracting more migrants who were looking for better chances in Cairo on the other. Consequently, the total population reached 9 million inhabitants by the mid 1990s as shown in Fig. 6-5. In this period, the rapid population growth was not accompanied by a similar growth in housing and infrastructure leading to the increase of the informal housing all around Cairo. It is estimated that as much as 4 million inhabitants were living in illegal settlements. (Yousry & Aboul Atta 1996). Since that time the city has continued its rapid growth in terms of both population growth and urban growth. By the year 2000, the total population in GCR has passed the 15 Million inhabitants and the total populated area has reached more than 500 sq. km. Population growth in Cairo is attributed to three main reasons.

- The overall natural growth rate during the last decade of the 20th century population growth was 2.3% annually. It decreased to reach 2.0% at 2002 (The World Bank Group 2003).
- The improvement in the health care leading to the increase of the life expectancy at birth from 41, 61 and 67 years in 1960 and 1990 and 2002 respectively (The World Bank Group 2003).
- The accelerating migration from rural areas to cities. In addition, some of the population growth has resulted from the influx of refugees from the cities along the Suez Canal that was damaged in the wars of the late 1960's and the early 1970's, Fig. 6-6.

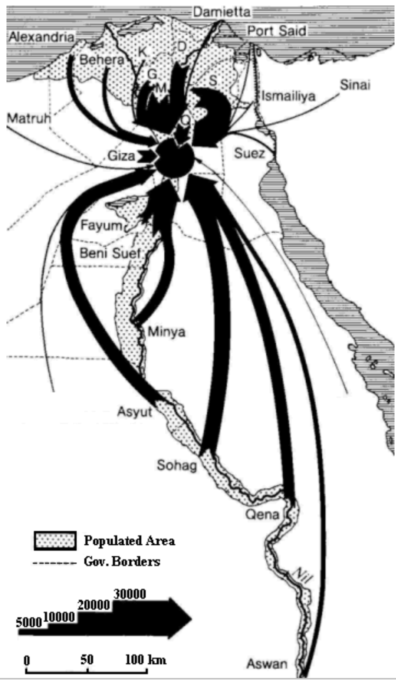


Fig. 6-6. Internal migration to GCR between 1971 and 1976

Source: ACR 1982 in Meyer 1989

One of the main side effects of this rapid population and urban growth is the increase of informal settlements. Informal settlements are those districts built on the outskirts or inside the urban agglomeration of the city in violation of laws. This violation includes building on agricultural lands which is prohibited in Egypt or building on a public land. In both cases, building takes place without permissions and without considering planning standards. According to the typology of these settlements, the following types of informal areas could be identified:

- Growth of rural villages near the urban agglomeration over the agricultural land,
- Growth of peripheral formal districts over adjacent agricultural land as shown in Fig. 6-7,
- New informal areas over desert land on the outskirts of the city.

In addition to informal settlements, there are other types of informal housing such as marginal housing, shanty towns and the city of the dead.

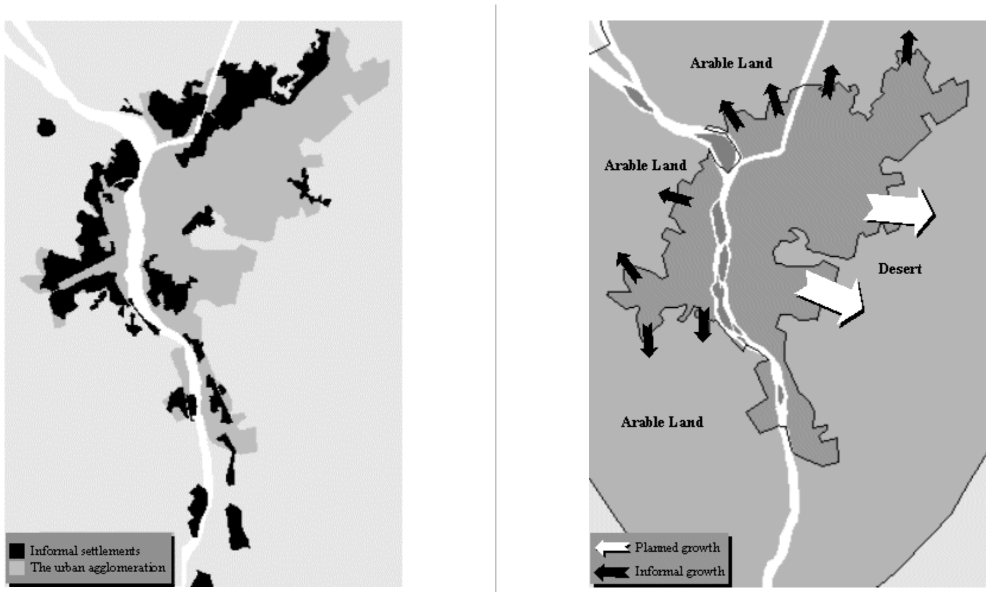


Fig. 6-7 Informal settlements around GCR - formal and informal growth trends

Informal construction on arable land is not limited to Cairo; it has reached phenomenal dimensions in Egypt. The consumption of arable land for building accompanied by the population increase has resulted in the decrease of the per capita share of arable land from 0.42, 0.18, 0.085 and 0.05 Hectare in 1800, 1900, 1965 and 2000 respectively. To face this unwished growth, the master scheme of Greater Cairo Region that was prepared in the early 1980s has adopted a strategy for urban development that implies steering urban development to the desert and reducing the consumption of arable land to zero. However, this goal was far from being achieved, consumption of arable land has continued regardless of the establishment of several new communities on non-arable land outside the region (fig. 6.8). After 14 years, in 1996, this strategy was supported by a decree that prohibits construction on arable land and made such structures a criminal act. The consumption of arable land in GCR as well as in all parts of the Nile Valley and the Nile Delta has continued its uncontrolled increase. Since 1996, after the afore-mentioned decree was declared, more than 400,000 cases of violation were registered in all parts of Egypt, which resulted in a total consumption of arable land of more than 2000 Hectare per annum. In the Governorates of Cairo, Al-Giza and Al-Qaliubia, the three governorates that compose GCR, the consumption of arable land since 1996 is estimated to be 155, 140, 255 Hectares per annum respectively (Al Ahram 25.02.2003). Consequently, the average consumption of arable land in GCR ranged between 300-500 Hectares per annum since 1996.

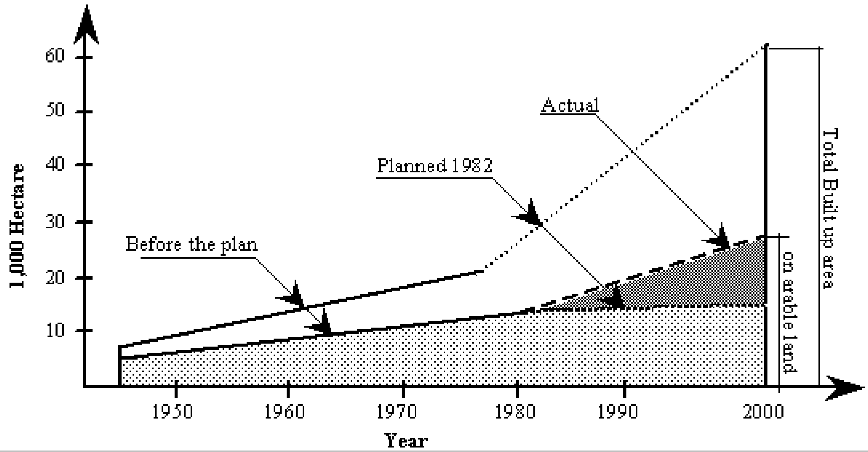
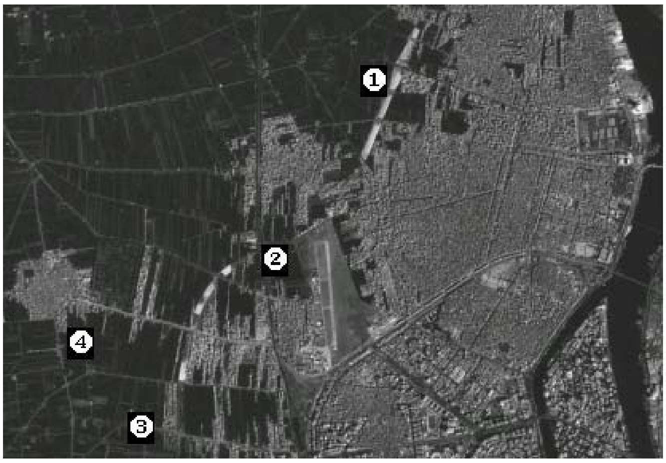


Fig. 6-8 Planned and actual built-up area on arable land in GCR

Source: based on information from Greater the master scheme of GCR, GOPP/OTUI-AURIF, actual state is calculated from in formation in Al Ahram newspaper from 25.02.2003

During this spatial growth, the agglomeration of Cairo contained into its tissues both agricultural lands and other non-urban land uses such as industry, military sites, airports and cemeteries. In many cases large cemeteries or military sites extended several kilometers inside residential areas. In other cases, heavy industries and airports that were outside the urban agglomeration are surrounded by houses.



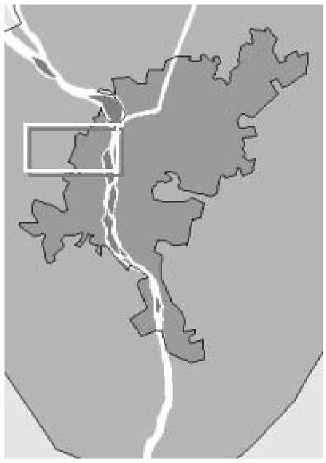


Fig. 6-9 An example of informal urban growth in GCR (Imbaba, north west of Cairo)

Fig. 6-9 represents an example of the mixture of unorganized and unplanned land uses in Imbaba north west of Cairo. From the satellite image, the following aspects could be clearly observed:

- 1. The new ring road surrounded by informal settlements.
- 2. Imbaba Airport Surrounded by informal settlements. The airport was closed at the end of the 1990, as it became unsafe for navigation.
- 3. Informal growth of a conventional district on arable land,
- 4. Informal growth of a village on the arable land.

Physical restrictions:

The urban agglomeration in GCR extends along both sides of the Nile from the south to the north for more than 30 kilometers. This agglomeration covers an area of more than 500 sq. km. The average population density in GCR is about 30,000 inhabitants pre square kilometer. The urban growth of GCR was steered by some natural factors. GCR is bordered on the east by the Mokattam Hills, separating the city from the Eastern Desert and Abo-Rawash Hills and the Western Desert to the West. These natural conditions lead to easier expansion of informal growth to the north on fertile delta land.

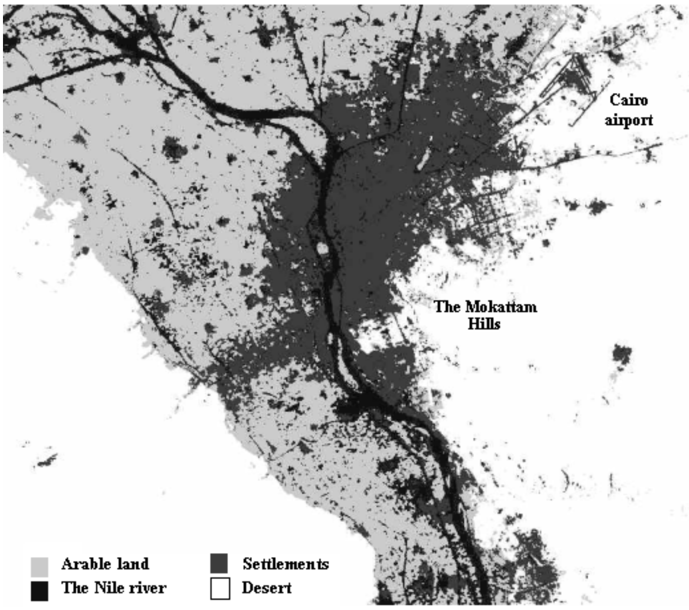


Fig. 6-10 Natural growth restrictions in GCR

Source: Based on a Satellite image from 1991

Jurisdictional and organizational partitioning

While Greater Cairo Region (GCR) as a whole is considered one of the seven planning regions in Egypt, urban management is divided among three administrative subdivisions (Governorate *Mohafza)*. Cairo Governorate rules the major part of the metropolitan, Al-Giza Governorate rules the western bank of the metropolitan across the Nile, and Al-Qaliubia Governorate rules the northern part of the metropolitan. The role of Al-Giza Governorate extends to cover areas about 300 Km from Cairo, while Al-Qaliubia Governorate 100 Km. North of Cairo. This situation makes priority-setting for these two Governorates different from those needed for developing the capital and vice versa. Consequently, coordination for activities that affect the whole region or extend over the border of two Governorates leads directly to moving the implementation of such projects to a central authority. In other words, the urban administration in Cairo Region does not have the full control over development activities in the city since 1961 from the beginning of the “local administration system”. Although it is paradoxical, the fact is that the city administration has more control over development activities before this law than after it. In addition, different authorities are responsible for data collection and spatial databases.

In the absence of an advanced and capable body for organization and coordination between these different authorities, each authority is working on its own system and goals. Furthermore, the planning system can not keep pace with the rapid growth conditions in the absence of a continuous planning mechanism.

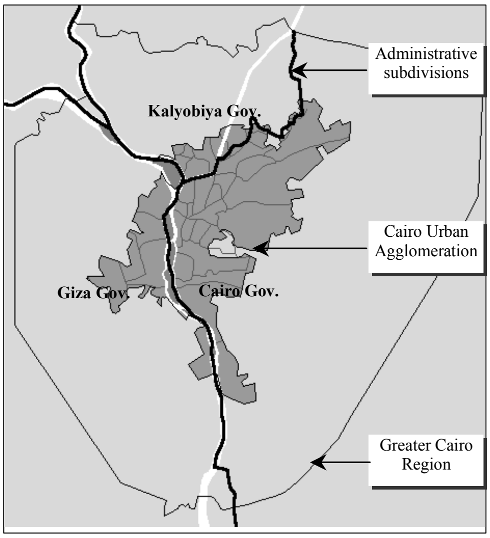


Fig. 6-11. Administrative subdivisions in Cairo

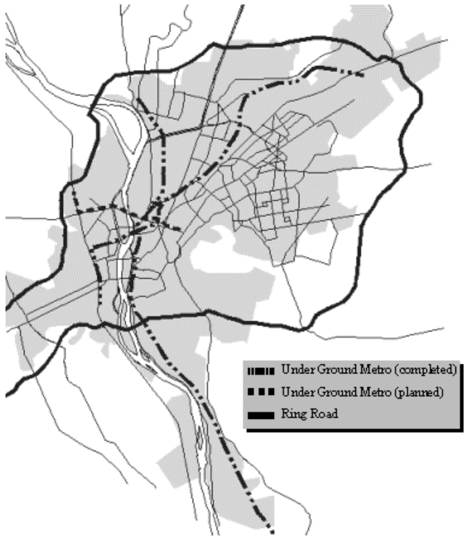


Fig. 6-12. Major infrastructure development GCR

Infrastructure development and spatial development

The absence of coordination between infrastructure development and spatial development in GCR could be observed in the informal growth of new settlements alongside newly developed highways. This absence could be also observed in the relation between the new Metro Network and the surrounding districts in many areas. This absence of coordination is attributed to the lack of coordination between the regional planning authorities and the authorities that are responsible for infrastructure projects, although both regional planning and infrastructure planning are conducted by central authorities.

As mentioned earlier, the regional planning in Egypt is the responsibility of the central agency for urban planning. This agency is directly related to the ministry of development and infrastructure and is responsible for planning in GCR as well as in all the other planning regions in Egypt. Similarly, almost every large development activity in GCR is conducted by central authorities - e.g. the Ministry of transportation is responsible for the development of Cairo Underground Metro, the Ministry of development and infrastructure is responsible for the ring road and the new towns around GCR and some cases for development projects inside Cairo such as the new residential districts (ESNB 1992). However, if such central authorities did not conduct such development activities, three different agencies from the three Governorates that compose GCR would be responsible for each type of infrastructures. For example electricity, water supply and sewerage are built and operated by separate authorities

6.2.3. Application of PIS

The need for a PIS: Regarding the above-mentioned circumstances and dynamics of urban growth in Cairo, an information platform is proposed to promote sustainable growth management of the region by facilitating the creation of an overview about the main issues that are related to the urban growth and to keep this overview up-to-date. The main goal of such an overview is to promote inner development vs. informal growth on arable land in the outskirts of the city. To achieve this goal, the proposed system may contribute in the following functions:

- creating an overview about inner development potentials and then to keep the concerned actors in touch with the changing circumstances. These actors should participate in creating this overview and in updating it,
- coordinating spatial activities specially infrastructure development to minimize conflicts and to reduce the danger of informal growth that usually accompanies such developments.
- identifying the threatened areas by informal growth.

In addition to these functions, the proposed system would support consensus building for inner development through the communication of knowledge about the planning strategies, concepts and objectives among the responsible authorities and other actors who participate in spatial development activities.

Development criteria: The development criteria in this case are based on the general development criteria of PIS that were discussed earlier. However, specific requirements should be considered regarding the above-mentioned characteristics of the situation in GCR as following:

- The supply of information, the access to the platform and the administration of the system should be decentralized.
- The system should be opened to other information sources that are already available to make use of it and to facilitate the integration of the proposed system into the information technology landscape in the region administration.
- The system should be dynamic to keep pace with the rapidly changing circumstances. It should facilitate updating available information and integrating new issues and subjects.
- Information organization should consider the hierarchy concept to facilitate exploring the large amounts of information in an abstract form and then getting more details by demand.
- The system should consider the modular structure in both of the information organization and the functions. This will facilitate exploring the information in different contexts and to administrate the user access right in a more flexible manner.
- The access scheme should define the responsibilities and the rights in respect to the information that is included in the system, taking into consideration the large number of actors that should participate in the system as well as their differentiated roles and tasks.

By attempting to translate these aspects into a development criteria matrix, it is clear that in this case the requirements are relatively high. As shown in the following table 6.2.:

Criteria	**Degree**							
	Min.	←					→	**Max.**
Time span	Short						✔	Long
Open to other Info. Sys.	Closed						✔	Open
# of users	Low						✔	High
The information								
Distribution of Supply	Central						✔	Distributed
Distribution of Access	Limited						✔	Distributed
# of classes of objects	Limited						✔	Large
Dynamism of content	Static						✔	Dynamic
Types of media	Alphanumeric						✔	Multimedia
The rules scheme								
Differentiation of users	Low						✔	High
The functions								
Database							✔	
Documents							✔	
Argumentation							✔	

Table 6-2 Cairo PIS development criteria matrix

- The time span of such a system is expected to be long. This means that the system should be developed in a way that could be extended.
- It is also clear that different participating actors use different standards and formats of information. While the proposed system is not regarded as a central data warehouse that collects all types of data from the different information systems, it should be possible to exchange information with other systems. It is more efficient to support specific standard formats for importing and exporting information with other information systems.

The information space

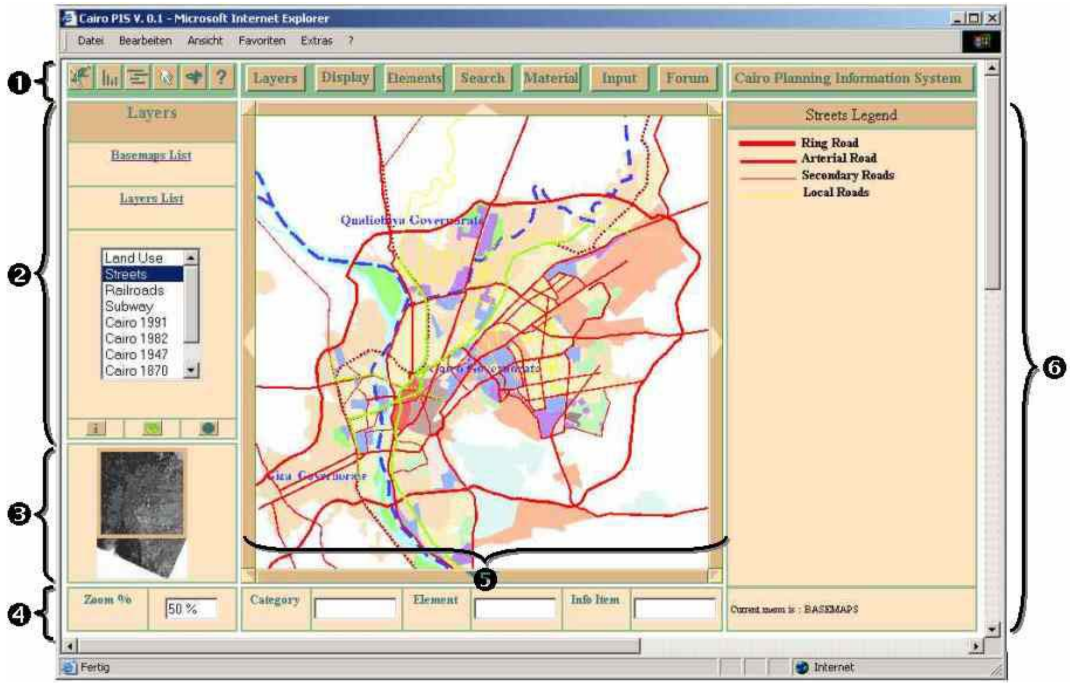
The information space includes different types of planning information that are related to the three information domains which were discussed earlier, i.e. the subject-matter domain, the process domain, and the planning knowledge domain.

- In the subject matter domain, different classes of objects are expected such as: projects, problems, potentials, conflicts, actors, plans, and ongoing activities, etc. However, further classes of information objects could be added by demand.
- The process domain includes information about issues related to organization, coordination, argumentation and decision-making. This information domain includes information objects such as participating actors in the process, tasks, time plans, etc.
- The planning knowledge domain includes information about issues such as legal bases for planning, planning standards and norms, case studies from different cities that have similar situations, etc.

Technically, the information space consists of a database for structured information and different types of documents. The database includes different tables for structured information as well as information about the available documents.

The user interface

The user interface (UI) has two functions. First, it gives the user an access to all possible functions according to his rights. Second, it is a visual environment to present the results of a user's queries and requests. When a user log on to the platform, the interface will be customized according to his access rights. He will get access only to the functions and the tools that he is authorized to use.



1. The tool bar	4. The statues list
2. The command area	5. The main area
3. The overview navigator	6. The information area

Fig. 6-13 The user interface in the case study of "Sustainable Growth Management in Cairo"

The user interface is a web page that includes only standard HTML code. It needs only the web browser with no need for any special programs (plug-ins). It consists of six main areas (fig. 6.14):

- 1. The tool bar: includes access to menus and functions.
- 2. The command area: the content of this area changes according to the selected set of functions from the tool bar.
- 3. The overview navigator: this area includes a context map that views the current position and scale relative to the larger map for orientation.
- 4. The status bar: includes information about the current settings and the active elements.

- 5. The information area is the area where the selected information is represented in the current selected mode (the map mode, the time line mode and the statistical mode).
- 6. The information area is used to represent the results of different types of queries.

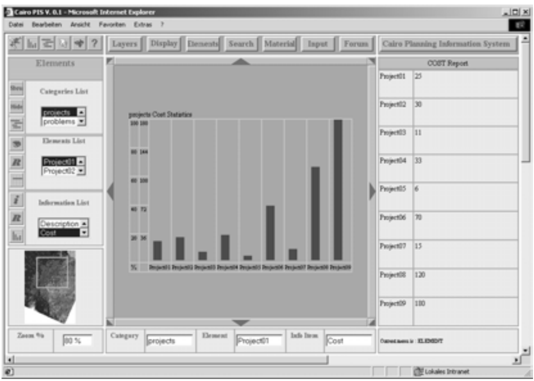
The functions and tools

To deal with the above-mentioned types of information, four main information modes are needed: graphical, alphanumeric, time line and statistical (fig. 6.14a to 6.14c). Different sets of functions are essential to deal with the information in these four modes as following:

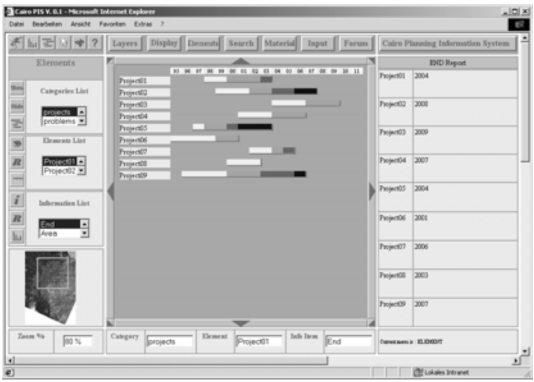
- The first group of functions, under the “Elements” menu (fig. 6.14), includes both primary and secondary information functions for exploring different classes of objects and the different elements in each class. However, it does not include access for adding new records or editing existing ones.
- The primary information functions for manipulation of existing information objects are grouped under the menu “Input”. Grouping these functions in different menus is needed to facilitate the access control that is based on activation or deactivation of different menus according to the user access right. This issue is discussed in more details in the rules scheme.
- The system included text-oriented search and sorting functions using different criteria (fig. 6.14). The results of these functions are represented in the form of a list accompanied with functionalities for browsing the document information, or viewing the linked documents if it is available in a digital form or accessing hyperlinks for more details. In addition, the results of queries are represented in the graphical mode.
- The menu “Material” includes access to the available documents and media files. These files could be distributed over different servers.
- Layer control functions are grouped under the menu “Layers”. This menu includes functions such as layer control and overlying. In addition, functions for the view control are grouped under the menu “Display”. This menu includes functions such as zoom and pan (fig. 6-14e).
- Further functions such as: statistical analysis, time line for different activities and discussion forums are also included (fig. 6.14e).

From a technical point of view, these tools and functions are server-side and client-side scripts that are written using a scripting language such as JavaScript or visual basic. Each function and tool is considered a component that runs independently from other components (e.g. a component for input, a component for overlaying, a component for search, etc.). The whole application runs on Active Server Pages (ASP) environment that runs most operations on the server side and sends standard HTML to the client. In addition, some client side functions are sent to the client, so that he can make some operations without being connected again to the servers.

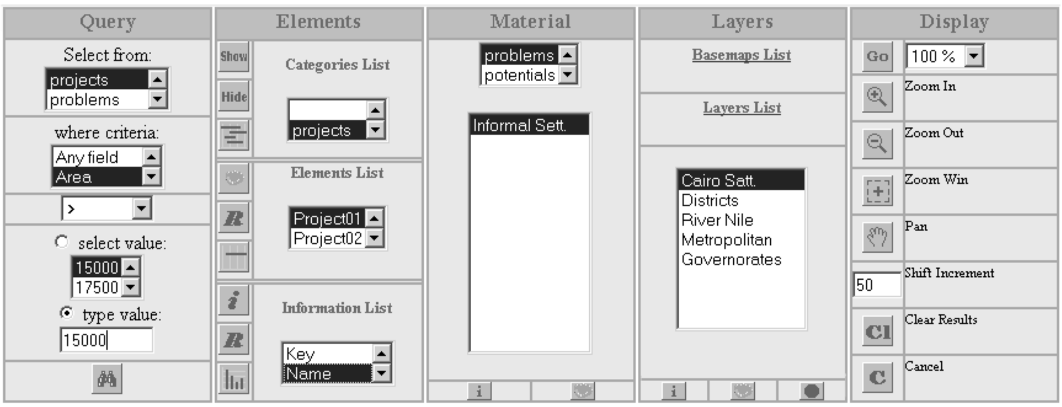
a. The spatial overview



b. The statistical mode



c. The time line



e. Menus of different sets of functions

Fig. 6-14 Different functions and modes of information in the user interface in the case of SGMC

One of the main functions in this case is the spatial overview. The spatial overview is a tool for graphical representation of shared information about different spatial activities including ongoing and planned activities. The importance of this overview in such a complex context emerges from the need for collaborative exploration of spatial problems and for coordination of spatial activities that are initiated and conducted by different actors in the region. These activities might be complimentary, conflicting or pre-required for one another. The collaborative overview should facilitate identifying conflicts between these activities or synergies that could be achieved by coordinating these activities. It should also facilitate identifying of problem areas and sharing information about these problem areas. This might contribute in defining threatened areas by informal growth.

Based on the hierarchal, modular and associative organization of information, the graphical overview allows exploring the spatial context on an abstract level and then exploring specific sub-region or a specific element in more details when needed. In addition, using different types and scales of maps, satellite images and aerial photos, the same aspects could be explored in different graphical contexts and different levels of abstractions. Different elements could be illustrated in the overview either in an abstract form as symbols or in a detailed form, that presents the physical form of an element. Toggling between the abstract and the detailed modes could be controlled using the mode buttons in the navigation bar of the user interface (the upper lift area in fig. 6-14).

The rules scheme

The users in this case are grouped according to their access rights to three groups: authorized users, registered users and public users. Each group of users has different access rights in respect to the information and the functions. The need for identifying groups of users emerges from the number of users that are expected to participate in such a system. Otherwise, it would be very complex if it were organized for individual users. However, individual access rights could be defined for individual users to access specific information areas or to use specific function based on the role and responsibility of each user. The concept of the access scheme is shown in the following matrix.

Criteria	**Public user**	**Registered user**	**Authorized user**
Public info	✔	✔	✔
Internal info	✕	⦸	✔
Restricted info	✕	✕	✔
Display	✔	✔	✔
Overlay	✔	✔	✔
Search	✔	✔	✔
Forum	⦸	⦸	✔
Analysis	✔	✔	✔
Input	✕	⦸	⦸
Legend:	✔ Full access	✕ No access	⦸ Individual access rights

Based on the access scheme, the user interface is customized according to the user access rights. For example, a user that has no right to add information to the platform will not get the input function in the tool bar in the user interface.

6.2.4. Concluding remarks

- The need for a planning information system that supports sustainable growth management in Cairo emerges from different reasons:
  - ∗ The situation of urban development in Cairo is witnessing an uncontrolled dynamics of urban growth. This growth consumes large areas of scarce arable land around the agglomeration.
  - ∗ The jurisdictional partitioning of the region into three administrative units adds further complexity for managing the growth in the region. Two of these administrative units are not only responsible for their parts of Cairo but also are responsible for other cities and villages that are far away from Cairo.
  - ∗ The physical circumstances in Cairo limit the possibilities of urban growth. During the unplanned urban growth in the last decades, different non-urban land uses exist inside the urban tissues. These areas represent potentials for urban development.

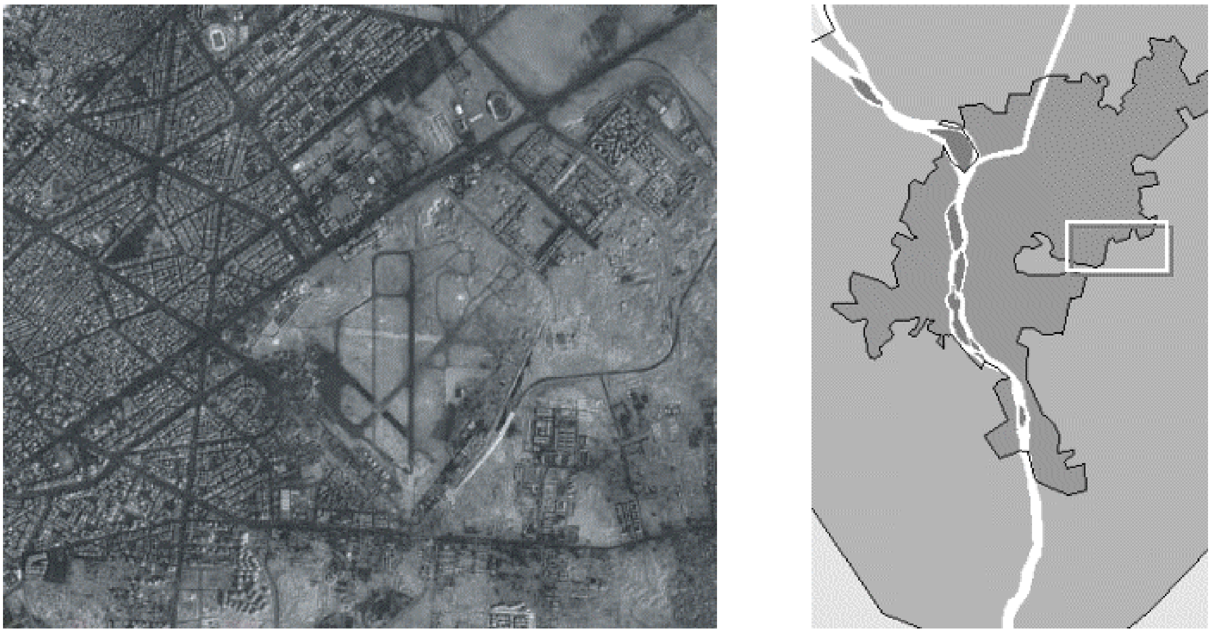


Fig. 6-15 An example of inner development potentials in Cairo (Almaza Airport, East of Cairo)

- Different large infrastructure projects are developed and planned at the time being. These projects require coordination with one another as well as with the overall development of the region.
- From these circumstances, different aspects should be considered in developing and implementing of PIS in this situation:
  - ∗ The number of participating actors is large. They have different roles and responsibilities.
  - ∗ Regarding the amounts of possible information and the rapid change in this information, the system should concentrate on the strategic issues that play an important role in the spatial development of the city.

- To achieve this strategic vision, all the important aspects should be reviewed to define major problem areas, major activities and major actors in the area. In other words, the following elements should be defined: the needed information and key figures (indicators and parameters) to handle these problems as well as the main concerned institutions that will contribute and benefit from this system.
- This information system should be designed to give an indication of possible areas of further informal and unplanned growth inside and outside the built up area
- As such complications and local circumstances surround planning urban development and local administration in Egypt, adoption of a pre-prepared system or mechanism for planning urban development would be a matter of unreality. The needed system or mechanism should take into consideration the local conditions in order to benefit from their potentials and deal with their problems. Historically, each agency would have its own database, and then continually maintain their own data as well as data obtained from other sources.
- A PIS is proposed to link different authorities concerned with the spatial development in Cairo. The main goal of this system is creating an overview about the main issues related to urban growth of the region. Among the main aspects that should be considered in this system:
    - potentials for inner development,
    - areas threatened by informal growth,
    - ongoing development and planning activities.

6.3. The case study of Sustainable Land Management in Stuttgart (NBS)

6.3.1. Background

The subject matter:

The case study of “Sustainable Land Management in Stuttgart” (Nachhaltiges Bauflächenmanagement Stuttgart NBS) deals with a project that is concerned with promoting the strategy of inner development in Stuttgart. The concept of planning information systems, as introduced in this research, was implemented to establish an information platform that serves as a tool in this strategy. NBS is a research project financed by the ministry of environment and transportation in Baden Würtumberg in the context of the research program BW Plus.

Participating actors:

NBS is a cooperation project between the city of Stuttgart (department of city planning and the department of environmental preservation), urban and regional planning institute in the university of Karlsruhe (ISL) and the consulting firm Kommunal Entwicklung GMBH (KE).

Regarding the information platform, more than 50 planners and experts from different departments in the city administration of Stuttgart have participated in the project.

The time frame:

The official start of NBS was April 2001. However, the planning and the development of the planning information platform have started in March 2001. The project was officially ended in March 2003.

The project period of NBS was two years and was divided into three phases. The first phase was devoted to establishing the overview through developing of information platform. The second phase was the consolidation phase for consolidating the overview and exploring development potentials. The third phase was devoted to developing the strategy and the implementation phase.

6.3.2. Characteristics of the situation

Stuttgart as one of the major industrial centers in Germany has witnessed a rapid urban growth for several decades in the second half of the twenties century. This urban growth was initiated by an intensive increase in the investments in the industry sector during the 1950s and the 1960s, and later in the services sectors. The resulting growth in job opportunities led to a similar increase in population to fulfill the demand on labor force. This rapid growth in jobs and inhabitants lead to an intensive increase in the total number of residential units. These developments lead to a rapid urban growth since 1950 to fulfill the demand on residential, industrial, services areas as well as infrastructure and roads. This growth, in the form of urban sprawl, took place, to a large extent, on green fields on the outskirts of the city leading to more demand on private passenger vehicles and hence to more pressure on the road network. To keep pace with these developments, immense investments were devoted to the sectors of infrastructure and public services. However, the costs of these projects are not limited to the capital costs, but they include intensive running and maintenance costs that are indispensable.

However, since 1970, Stuttgart is witnessing a negative demographic development. In addition, economic growth, as indicated by the total employment, is witnessing negative development since 1990. These developments were accompanied by economic, technical and operational changes in all of the industrial, infrastructure and services sectors; the thing that resulted in the formation of large abandoned or underused sites. To a large extent, these sites are located inside the city in good accessed locations by public transportation.

Facing these facts, Stuttgart development plan 2010 (FNP 2010) adopts inner development of the city as a strategy for sustainable urban development. It was essential to identify inner development potentials as a pre-requirement for the realization of this sustainable inner development. Then it will be possible to define which developments are reasonable and which conditions govern these developments.

Growth dynamics in Stuttgart (Demographic, economic and physical)

By the year 2000, the settlement area of Stuttgart has reached about 50% from its total administrative province, which consists of more than 20,000 hectare. This growth took place mainly during the 1950s and 1960s as the land consumption has reached more than 100 hectare per annum due to the rapid industrial growth. In spite of this high rate of land consumption, the population density in Stuttgart is more than 50 inhabitants per hectare, which makes Stuttgart one of the densest cities in Germany.

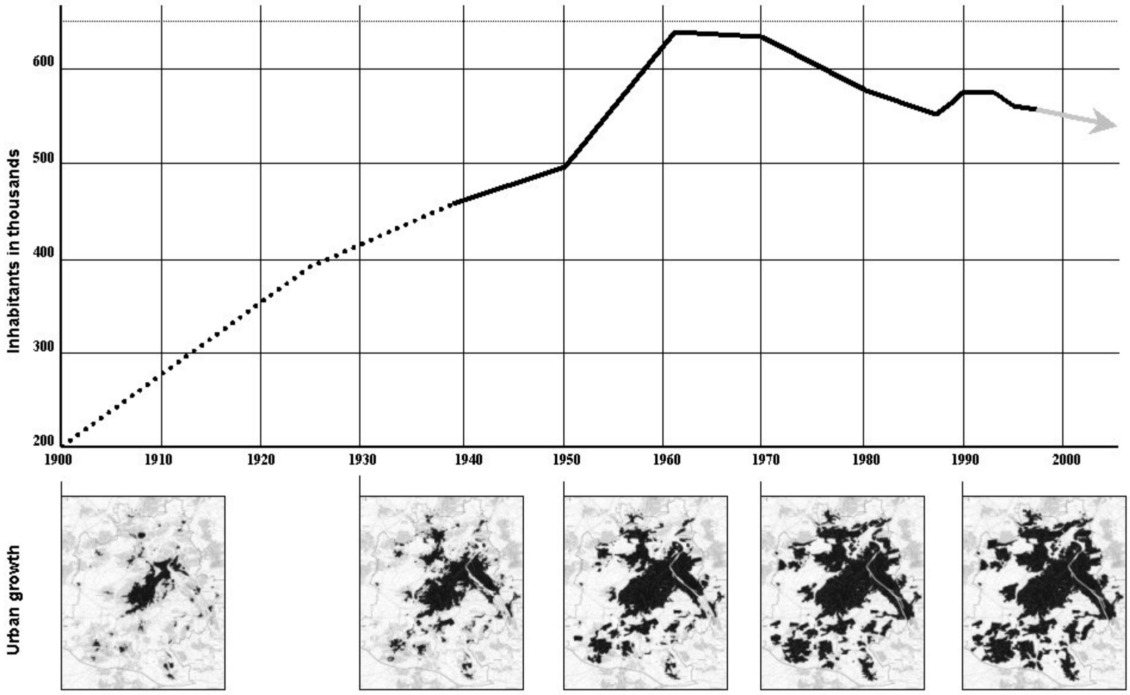


Fig. 6-16. Demographic and urban growth in Stuttgart since 1900

Source: based on several data sources from the department of city planning in Stuttgart

This contradiction between the increasing density and the increasing land-consumption could be explained by the rapid immigration rate of labor force that has accompanied the industrial growth to fulfill the needed manpower for this industrial boom. This lead to a total population increase by approx. 30% from about 500,000 inhabitants in 1950 to approx. 640,000 in 1960. After the population growth reached its peak during the 1960s, it started decreasing until it dropped to 550,000 inhabitants during the 1990s. In spite of this population decrease, land consumption continued its ascending trend. Nevertheless, this growth took a lower rate of 25 hectare per annum during the 1990s.

This contradiction between the demographic decline and the continuous increase in land consumption is attributed to the increase of per capita share of residential areas as well as the high demand on bureau areas in the services sector.

During the last two decades, an average of 450,000 sq m² floor area are developed in Stuttgart annually. The land use plan for Stuttgart 2010 (FNP 2010) foresees that the same amount of floor area is required yearly to fulfill the estimated demand. Although this consumption presents only 25% of the earlier consumption during the former decades, the growth trend could not continue in the same trend for several reasons:

- Stuttgart is located in the Neckar valley and is surrounded by mountains from all sides. This topographic situation represents a limitation for urban growth regarding the steep slopes in many areas.

- This topographic situation limits the air circulation in the valley, which represents a restriction on high buildings regarding the defined air corridors.
- From an economic viewpoint, regardless of these natural restrictions, it is apparent that the extensions of the urban agglomeration add high costs for maintaining the infrastructures in the form of roads, public transportation or technical infrastructure such as water supply or sewage networks.
- If the population growth continued in this dispersed pattern, the density would decrease. As a result of this low density, the costs of public transportation would not be feasible. In turn, this would lead to increasing the use of private vehicles. Consequently, this would result in traffic jams and an increase of the polluting emissions.

The strategy of inner development in Stuttgart

FNP 2010 in Stuttgart presents a vision of Stuttgart as a compact, urban and green city. This concept is aimed at overcoming the negative effects that resulted from the rapid urban growth, avoiding the expected unwished outcomes of the high consumption of green fields and at the same time guiding urban development in Stuttgart to sustainability. Contrary to the earlier rates of land-consumption, FNP 2010 estimates only the consumption of 130 hectare of new land during the plan period in the coming 10 to 15 years. This amount of land consumption is equal to the consumption of land in one year during the 1960s. To meet the afore-mentioned estimated annual consumption, the rest of the land should be developed inside the city with a ratio of 4:1 for inner development.

However, formal planning instruments are usually limited in supporting the inner development of cities. Planning laws were prepared for the times of urban growth and are mainly oriented towards building in the outskirts of the city and not for the redevelopment of internal reserves of the city. One of the main steps to implement the strategy for inner development is getting an overview about inner development potentials in the city. Then, based on this overview, it will be possible to identify priority areas and to develop a strategy for developing these potentials. NBS is aimed at developing the needed overview about the inner development potentials in the urban agglomeration of Stuttgart. NBS is considered an instrument for supporting the efforts of the city for promoting inner development.

6.3.3. The application of PIS

The need for a PIS: NBS information platform is aimed at creating the afore-mentioned overview to inner development potentials, then to facilitate keeping it up-to-date and accessible for the concerned actors in the city planning administration. However, the information that is needed to achieve this overview is distributed over different departments and agencies in the city administration. In addition, it is not enough to collect the information by the conventional questioner techniques that produce a snapshot overview, which does not support the sustainability of the process. Moreover, regarding the rapid changes, which occur in Stuttgart, it is important to assure a continuous access for updating the overview and to facilitate getting the actual state of developments for decision makers.

Based on this overview, the city administration would have a general idea about development potentials in the city. Then it should be able to define priority areas for inner development and in some cases to deal with a group of pieces of land as an integrated area and not as separate land parcels. This will help the city administration when dealing with investors who are intending to invest in development projects in the city. Contrary to the normal case, when an investor selects a specific piece of land for a specific project and then apply for the building permission, the city administration will be in a position that allows offering alternative locations that fulfill the investor's requirements meanwhile considering the city development considerations.

Development criteria: For the proposed information platform to be an aid for promoting inner development in Stuttgart, a set of criteria should be considered in developing the system. Regarding the system structure, the system should be decentralized and open. Regarding the information organization, it should be dynamic, hierarchical and modular. In addition, it should facilitate exploring the planning information in different contexts and representations. In the following paragraphs, each of these criteria is discussed shortly.

a. Decentralization

The need for a decentralized system in this case emerges from the fact that the needed information to set the overview about inner development potentials is distributed both geographically and disciplinary. On one hand, Stuttgart is divided into 22 districts "*Bezirk*". Each of these districts is under the responsibility of a district planner and a surveyor in the department of city planning. On the other hand, different agencies and departments in the city administration are responsible for specific aspects for the whole city. For example, the department of environmental preservation and the department of economic development are responsible for specific aspects about these inner development potentials throughout the city. The concept of decentralization, in this case, is applied in three dimensions, namely: supply, access and administration.

- As far as the supply dimension is concerned, information is supplied by the following groups:
    - ∗ District planners and surveyors in the city-planning department, should supply information about inner development potentials in their districts.
    - ∗ Different specialists in the department of environmental protection should supply information about their areas of specialty e.g. air, water, soil, and
    - ∗ Members of the economic development department should be able to add information about investments and the ongoing activities.

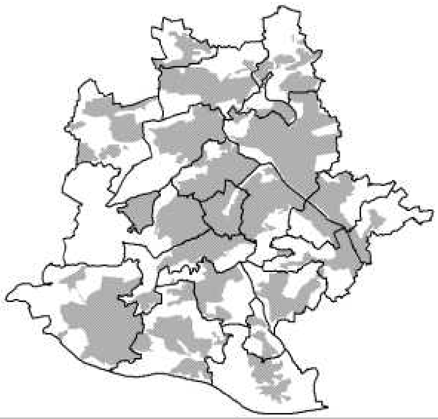


Fig. 6-17 Administrative subdivisions in Stuttgart

- On the consumption side, primarily the above-mentioned groups are the main information consumers. In addition, different members of the city administration should have access to the information according to their tasks and responsibilities. This includes specially members of the top administration and decision makers. Furthermore, it is planned that information about specific areas shall be available for investors as a tool for supporting marketing of inner development potentials.

Decentralization of supply, consumption and administration of information is regulated by a three-dimensional access scheme that will be discussed in a later section in details.

b. Open system

As discussed earlier, a system is considered an open system if it interacts with the surrounding environment. An open system gets input from its environment, processes this input and returns the output to the surrounding environment. The system is considered also an open system if it interacts with other systems that exist in its environment. In the case of NBS, the concept of an open system is applied on two levels. On The first level, NBS information platform should be open to the surrounding environment. Different actors input information about different aspects to the system. The system processes this information by encoding, recording, structuring and organization of this information. Then, different actors use this information for various purposes.

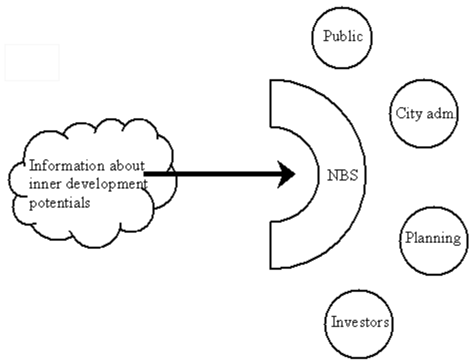


Fig. 6-18 NBS as an open system to actors in the surrounding environment

On the second level, several information systems exist in the information landscape of the city administration in Stuttgart including databases and geo-spatial information. Among these systems, the following are only few examples:

- SIAS (Spatial Information & Access Service / Geographic and spatial information system)
- ISAS (Informationssystem Altlasten Stuttgart / Soil contamination information system)
- ALB (Automatisiertes Liegenschaftsbuch / Cadastre information system)

To make NBS information-platform an open system to other information systems in its environment three alternatives are discussed:

- The first alternative is to make NBS a stand-alone closed-system. This leads to the duplication of effort to create and maintain information that already exists in other systems. In the long-term, these circumstances might lead to making NBS information-platform an island in the landscape of IT in Stuttgart. This situation is similar to creating 'electronic concrete' between these systems. This situation results generally from the decentralized uncoordinated development of information systems in different organizational units that are mutually incompatible. Furthermore, this situation would create an E-Barrier among different work elements in the city administration, which consequently constrains the scope of activities that the organization can undertake, or imposes substantial additional time and financial costs on those activities (Laudon & Laudon 1995).
- The second alternative suggests creating several interfaces to facilitate information exchange between NBS and each single information system in the city administration. This alternative requires intensive investments in the form of time, effort and money. It might lead to a very complex system.
- The third alternative implies making NBS an open system in a way that accepts input using the most important currently used standard data formats and to output information in these formats. Then, the other systems should be able to deal with these standard formats.

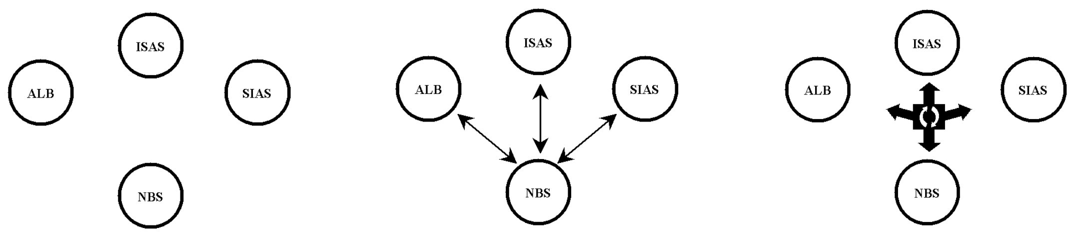


Fig. 6-19 Alternative solutions for implementing the concept of an open system

It was neither reasonable nor acceptable to deal with NBS as a closed system that is isolated from all the surrounding systems. Meanwhile, it was also not reasonable to prepare an interface between NBS and each single system for exchanging different information standards and formats. The third alternative was implemented as it avoids the simplification of the first alternative, which is associated with unacceptable loss of effort and information. Meanwhile, it avoids the complications of the second alternative. The adopted solution is based on using an interface that supports different standard information formats for both tabular and graphical information.

c. Dynamic

The concept of dynamism in this research implies two aspects. The first aspect comprises that the system could be initiated with a core of information and functions and then it should grow through the application. The second aspect covers the systematic updating of the system content. These two aspects are important in Stuttgart for several reasons:

- Regarding the dynamics of urban change and the amount of inner development potentials in Stuttgart, it is clear that a static overview does not fulfill the needed requirements of the overview. In addition, regarding the effort needed to establish this overview and then to keep pace with the rapid rate of change, it is essential to start this overview with a core that could be extended when necessity arises. This core consists of some basic information about some of the important areas.
- Information about these potentials is not static. It is changing. Hence, the overview should be extended and updated within the course of time. Therefore, it must be connected to the participating actors to get their actual information. Meanwhile, if this overview is updated systematically, then actors should be connected to it to get the actual state of knowledge about the situation. This connection between actors and the overview should be sustained.

The following figure 6-20 shows an abstract representation of the database that includes the inner development potentials in different time points. In this database table, information is growing in three dimensions. The vertical growth means that new objects are added to the table in the form of new potential development areas. The horizontal extension is due to the addition of new attributes that should be collected for some or all the objects. The third dimension is the intensification of information by filling the gaps when more information is becoming known or needed.

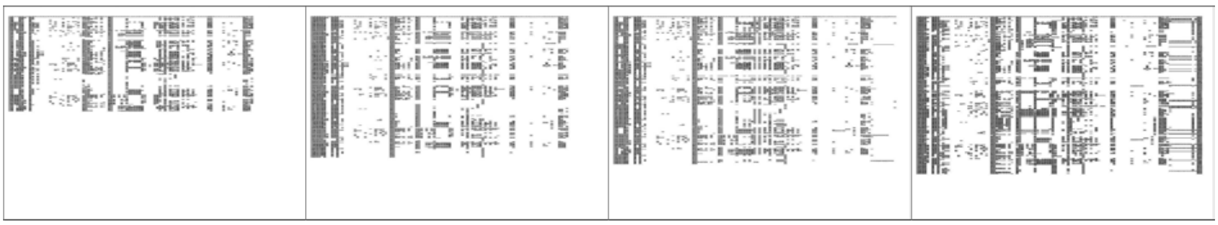


Fig. 6-20 The quarterly growth of content in NBS

d. Hierarchy

The system content is organized in a hierarchical structure. On the overview level, only abstract information is represented to get a general idea about the whole city. From this overview, the user can concentrate on a sub area where more detailed information is represented. This information is organized in the form of different layers that could be switched on and off according to the users' need. From this level, the user can open a specific element on the map to brows the detailed information.

Fig. 6-21 Hierarchical organization of information in NBS

This hierarchical organization of information avoids the information overload and gives the user only information according to the level of details he needs. Meanwhile, it gives him the possibility to define the level of details or abstraction of information according to his preferences.

e. Modularity

Modularity is applied on three levels: the system structure, the functions and the information organization. Principally, the system is modularly structured by splitting functions, information, rules scheme and representation in order to facilitate developing and improving each component without affecting the others.

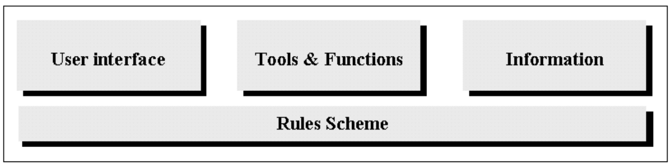


Fig. 6-22 Modular structure of NBS information platform

On the functions level, functions are modularly structured so that each function could run independent from other functions. On the information level, each information object is considered a module and different set of attributes of the object are grouped into sub modules. For example, environmental information, planning legislations and the urban context are considered different sub modules. This modular structure of information and function facilitates administrating the access rights in several dimensions: geographical, disciplinary and operatively.

f. Information in multi contexts and representations

Different pieces of information could be viewed in different contexts or in different forms of representation. Using different types of information representation activates different senses of the receiver; consequently, the perception of information would be higher. The same piece of information could be presented in different contexts and levels. This leads to viewing the same conflict, project or problem from different perspectives allowing a better perception of the subject.

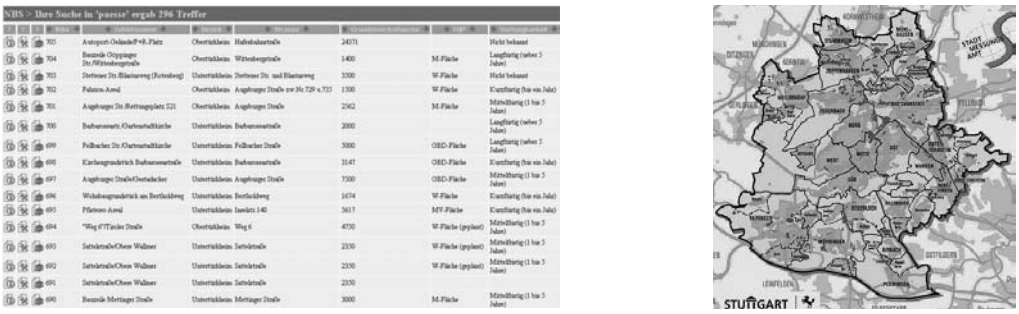


Fig. 6-23 Tabular and graphical representation of information in NBS

The matrix of development criteria: The following matrix concludes the main development criteria for the information platform.

Criteria	**Degree**							
	Min. ←							→ **Max.**
Time span	Short						✔	Long
Open to other Info. Sys.	Closed				✔			Open
# of users	Low						✔	High
The information								
Distribution of Supply	Central					✔		Distributed
Distribution of Access	Limited						✔	Distributed
# of classes of objects	Limited		✔					Large
Dynamism of content	Static			✔				Dynamic
Types of media	Alphanumeric					✔		Multimedia
The rules scheme								
Differentiation of users	Low					✔		High
The functions								
Database management							✔	
File management							✔	
Argumentation				✔				

Table 6-3 System development criteria matrix

Four main groups of criteria are included as following:

- It starts with some general aspects about the whole system such as the time span, the number of users and the system openness to other systems.
- A second group of criteria covers the information including the number of classes, which the system should deal with, as well as the type and dynamism of this information. It deals also with the spatial pattern of information supply and information consumption.

- The third group is related to the rules scheme. If the users are differentiated according to their rights in the systems, the rules scheme should accordingly be multi-dimensional. In the case of NBS, it is a three-dimensional. This issue will be discussed later in more details.
- The fourth group of development criteria is concerned with the functions that should be included in the system

6.3.4. Main components of NBS information platform

a. The information space

Conventional information modeling is mainly used for modeling well-defined information. Such information is normally processed or produced in processes that could be described as routines. In contrast, planning tasks such as inner development of cities and consequently the needed planning process could not be described in routines. In such processes, the information objects are ill defined, the participating actors are not definitively identified and information flow is not transparent. Participating actors in the process have different backgrounds regarding the multi-disciplinary nature of the process. These actors have different priorities and different goals that are sometimes conflicting. For these reasons, information about inner development is fuzzy and not clearly structured.

In attempting to describe the information structure that is needed to share the information about inner development potentials in Stuttgart, it was evident that there is a lack of a common language for dealing with such a situation among the participating actors. Achieving such a common language was a problem especially in dealing with qualitative information such as the proposals about future developments, the needed actions for developing a specific area and the personal judgment about 'why a specific area was not developed in the past'. For example, there was a lack of agreement about the definition of the potential area that was crucial for the whole process. The definition that was adopted of a 'potential area' for inner development is not limited to 'what is available at the moment' but it is extended to cover 'what could be available in the future'. This definition is subject to the personal judgment of the planners. In many cases what was regarded by one person, as a potential was not the same for others. Another example for this type of information is the description of the availability of a piece of land for development. Although a limited number of categories is used to describe the availability (short-term: less than one year, middle-term: from 1 to 5 years and long-term: more than five years), it was clear that the personal judgment is subjective and does not essentially represent the realistic needed formal processes and activities to utilize an area.

It was then essential to structure the information in this process in an explorative process that takes several cycles of development and evaluation in an iterative process.

- The first cycle was mainly concerned with setting a list of important attributes for the class of objects 'potential area'. This list was discussed in the project group as well as with different departments and agencies in the city administration to ensure that none of the important aspects is ignored or duplicated. The resulting list of attributes was very immense.

- The second step was aimed at optimizing the list of attributes and then in creating groups of attributes in the form of modules that represent the different areas of information (Fig. 6.24). As each module is related to a specific discipline, it was possible using this modular structure to control the access rights according to the information content. In addition, this modular structure allows each user to customize the information content according to his preferences without being overwhelmed with information that are not relevant for him.

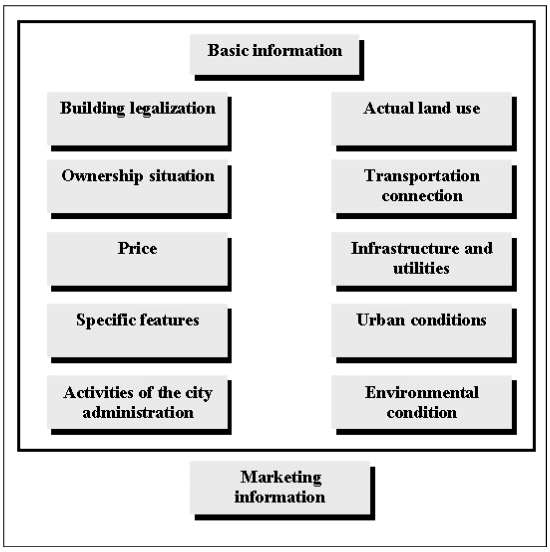


Fig. 6-24 Information Modules in NBS

- Specific types of information about private properties could not be published without the agreement of the owner because of privacy issues. Hence, generally, information in NBS is not publicly accessible. It is mainly used for internal purposes in city planning and administration. However, for specific areas that should be marketed, specific information should be made publicly accessible. An additional module for public information is designed for such information, which is reviewed before making it publicly available.

<Class name = 'Potential Area' description = 'inner development potential' >
<Att. Name = 'Serial Number' Att. Type = 'Auto Value'>
<Att. Name = 'Name' Att. Type = 'String'>
<Att. Name = 'Parcel Number' Att. Type = 'String' Att. Multiplicity = n>
<Att. Name = 'District' Att. Type = 'List' Att. Multiplicity = 1 Value List = 'Mitte, Nord, Ost, ……., Weilimdorf, Zuffenhausen'>
//all districts of Stuttgart
<Att. Name = 'Address' Att. Type = 'String'>
<Att. Name = 'Total Area' Att. Type = 'Integer'>
<Att. Name = 'Total Realizable Floor Area' Att. Type = 'String'>
<Att. Name = 'Area Type' Att .Type = 'List' Att .Multiplicity = 1 Value List = 'I, II, III, IV, V, VI, VII'>
//I= Unused area, II = unused reserve area, III = underused area, IV = Extensively user area, V = Area used not according to the plan,VI = Special cases, VII = Residential area
<Att. Name = 'Owner' Att .Type = 'String'>
<Att .Name = 'Main Features' Att. Type = 'String'>
<Att. Name = 'Availability' Att .Type = 'List' Att .Multiplicity = 1 Value List = 'Under construction, Short-term, Middle-term, Long-term'>

Class definition of the object potential area

- The third step in creating this information structure is concerned with the definition of the class of objects, including a description of the attributes and their value span and content type. The following list includes the declaration of the class of objects “potential area”.

The following aspects are important regarding the proposed information structure in NBS:

- It was not the intention of the project to collect a comprehensive list of information about each area. There is a difference between basic information and extended information. The module of basic information includes the minimum needed information about any element in the system. This module includes information about the location of the element, the area, the land use according to the land use plan, main features of the area and possible realizable total floor area. On the contrary, extended information could be added according to the situation of each element.
- It was evident that not all types of information could be structured in a database in the conventional manner. Other pieces of information are unstructured such as articles, plans and different media types. It was clear that it is not enough to limit NBS in the form of a traditional database. It was important to set an information platform that accepts structured and unstructured information.

Fig. 6-25 Structured and unstructured information in NBS

- Beyond factual descriptive information, it was clear that different types of important information could not be described in a quantitative form. Qualitative information that represents the experiences, ideas and viewpoints of the planners and other participants such as
    - Normative information about proposals for future development ‘what should be the case’.
    - Ideas about the practical steps to realize the proposed development including who are the actors who should participate in the process to develop specific area and which formal or informal planning processes are needed to overcome the blockade situation and to promote the development process.
- Some types of information that are based in the personal judgment of one person were largely subjective. In several occasions, such information was far from the reality. Therefore, there is

a need for a set of tools to deal with issues such as time and quantities and the needed actions to realize some development in the future. This will support generation of objective information.

- Planning information is not neutral. In some situations, some actors might benefit from publishing specific information about their properties, while others might be disadvantaged.

b. The functions and tools

Function and tools in NBS are classified into three major groups, namely information handling functions, media-management-functions and system-administration-functions. As mentioned before, each of these groups is divided into smaller modules to allow administrating user access rights.

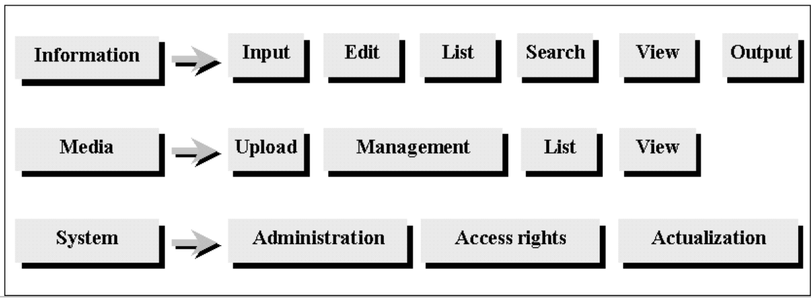
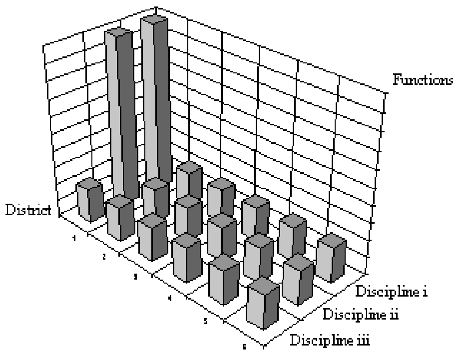


Fig. 6-26 Modular structure of functions and tools

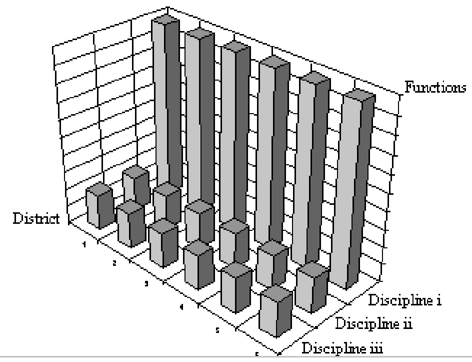
- Primary and secondary information functions for information handling including functions such as: 'input' 'manipulation', 'search', 'sort', 'list' and 'view' functions.
- Media-management-functions are all functions dealing with other types of information other than those in the database. They deal with different media types such as photos, news articles, videos or plans. This group of functions includes tools for uploading documents of different media types to the server to make it available for other actors. It also includes functions for listing available media files for a specific area as well as functions for file management i.e. rename, move and delete.
- System-administration-functions are all administrative functions such as user accounts administration. They also include functions to update the geographical information of the potentials when a new area is added, deleted or modified.
- In addition, there is a possibility to export directly the results of any query in a standard format that allows using it in other programs.

c. The rules scheme

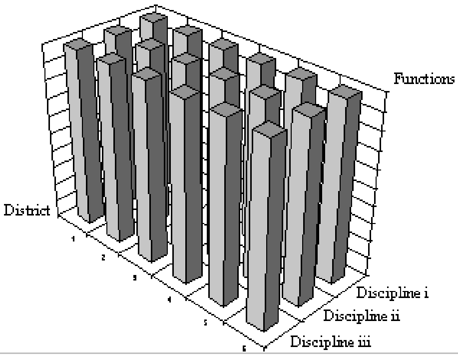
As mentioned earlier, the rules scheme in NBS is a three dimensional scheme. These three dimensions are functional, geographical and disciplinary. The first of these dimensions regulates the access to the functions i.e. which functions are available for each user, for example, 'add new elements', 'edit exiting elements', 'search', and 'delete'. The second dimension is concerned with the geographical responsibility for each member of the city administration. Some planners are responsible for only one district others are responsible for more than one. The third dimension deals with the disciplinary aspects. According to the responsibility of a specific user, he is allowed to add or edit specific areas of information. When a user logs on to the platform, his access rights are controlled against the rules scheme and according to his rights, he gets access only to those functions, modules and districts that he is authorized to access.



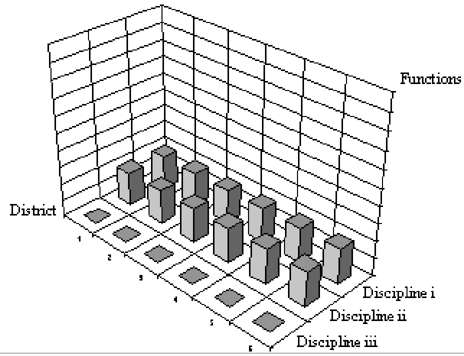
User A (a district planner)



User B (an environmental specialist)



User C (administrator)



User D (guest)

Fig. 6-27 The modular structure of the access scheme

Based on the three dimensional access scheme and the modular structure of information and functions, it is possible to define different combinations of access profiles for different users as shown in fig. 6-27. For example, a user (A), a district planner in the department of city planning, is allowed only to edit information for specific disciplines for district 1. Another district planner is allowed to edit the same information areas for district 2. On the contrary, a user B, who is a member of the department of environmental protection, is allowed to edit only the information area 'i' for all districts of the city but he is not allowed to add new elements for the class of inner development potentials. The user 'C' has full access to all information areas, city areas and functions. Such a user would be the system administrator. On the contrary, the user "D " is only allowed to view the approved information for specific areas that are publicly accessible while other information areas are restricted for him. Nevertheless, it was decided in this case that the access to available information should be granted to all authorized members of the city administration. This will facilitate achieving one of the main goals of this information platform which is informing all participating actors in the city administration about inner development potentials and to communicate these information among them.

d. The user interface

The user interface of a planning information system represents the gateway to the system. One of its main functions is the system security control. When a user logs on to the system, his access rights are controlled and then the user interface is combined to allow him to access only to the function and the information that he is allowed to access according to his profile in the database.

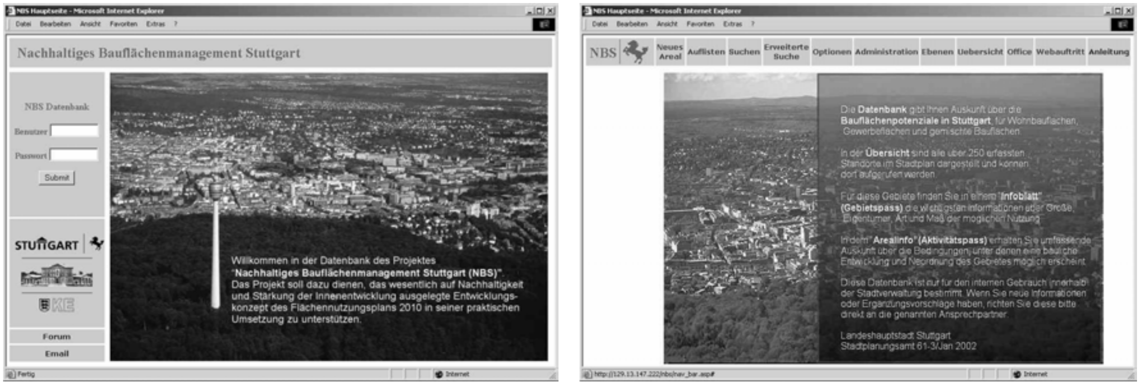


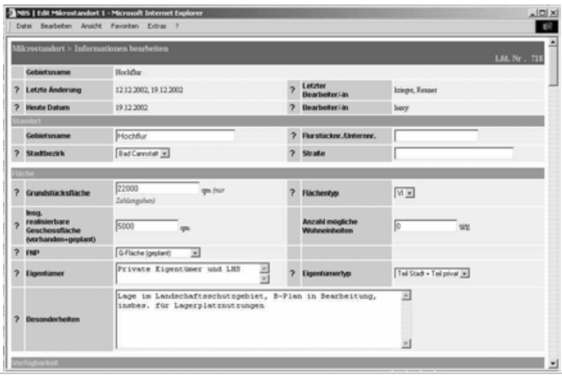
Fig. 6-28 The gateway and the internal area

The following table shows different navigation bars of different types of users. From this table, it could be seen that different user groups get access to specific functions and tools according to the rules scheme. Access rights could also be organized individually according to the user's rights.

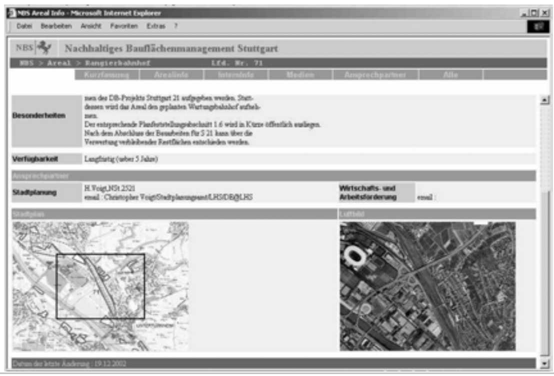
Administrator	NBS · Neues Areal · Auflisten · Suchen · Erweiterte Suche · Optionen · Administration · Ebenen · Uebersicht · Office · Webauftritt · Anleitung
User with full access	NBS · Neues Areal · Auflisten · Suchen · Erweiterte Suche · Optionen · Uebersicht · Office · Webauftritt · Anleitung
User with limited access	NBS · Auflisten · Suchen · Erweiterte Suche · Optionen · Uebersicht · Office · Anleitung
Guest	NBS · Auflisten · Suchen · Uebersicht · Anleitung

Table 6-4 Dynamic preparation of the user interface

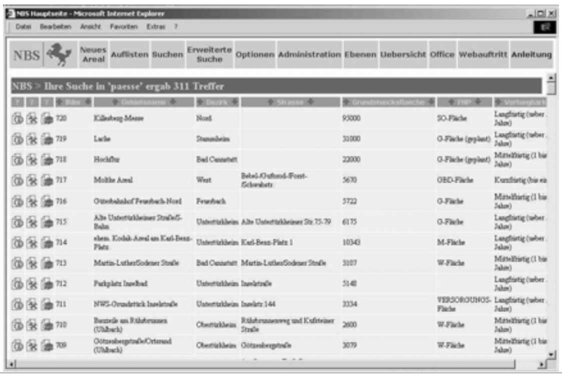
The user interface has three main modes, namely the alphanumeric interface, the graphical interface and the office area. The first mode is the alphanumeric interface that includes database management functions, media management functions and administration functions (fig. 6-29)



a. Add and edit an information record

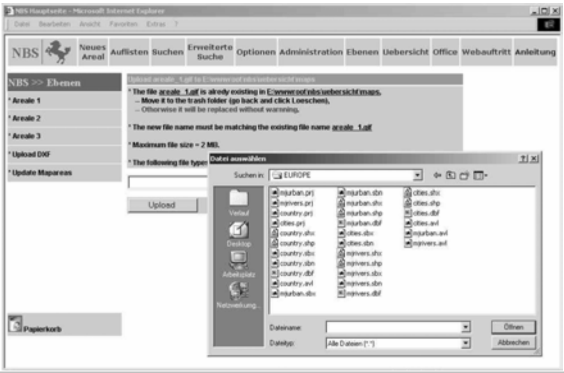


b. Browse an existing record



c. List and Sort

d. Search



e. Media management

Fig. 6-29 Different functions in NBS information platform

Source: NBS information platform online (Feb.2003)

The graphical interface facilitates a graphical access to all information in the system. Through this graphical representation, it gives an impression about the spatial pattern of distribution of the potential areas. Such a pattern is hard to recognize from the alphanumeric representation of information. Based on this graphical representation, it was possible to define main concentration areas that should represent a priority for the city administration.

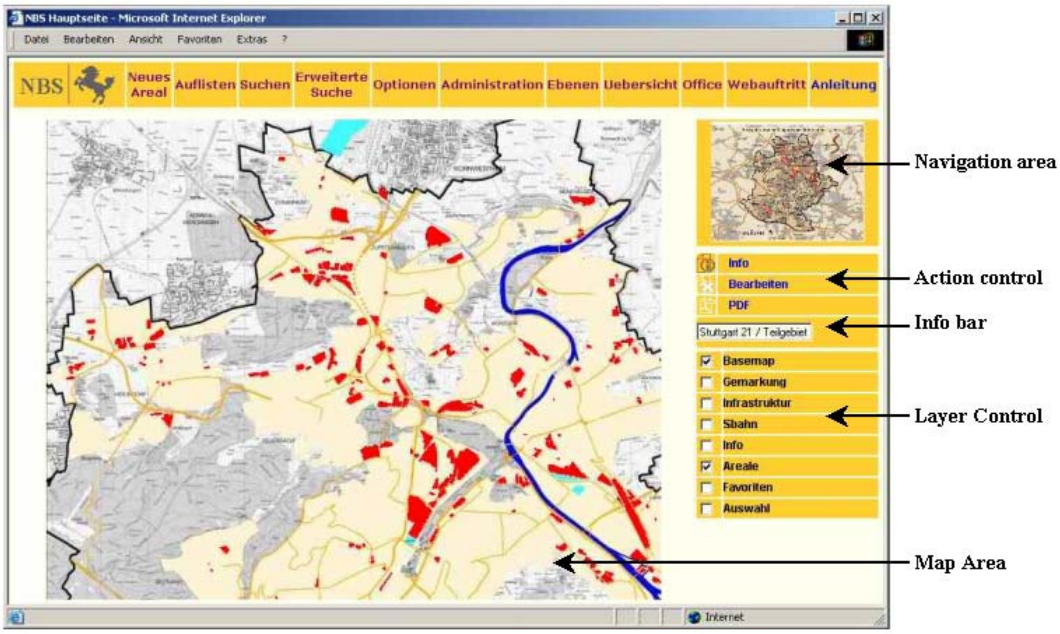


Fig. 6-30 The graphical interface in NBS information platform

For the purpose of the graphical representation, information is organized in a way that facilitates browsing the information in different levels of details and in different contexts. Three technical aspects are important to be mentioned here regarding this graphical interface:

- This graphical interface needs only a standard Internet browser. No special programs (plug-ins) are needed to use this graphical interface. This point was important because at that time it was not allowed to install programs on the work place computers other than the programs that are authorized from the IT department in the city administration for security and organizational reasons.
- In this case, the layers included maps in raster format. At the time of this project 2000-2002, vector graphics were supported in different browsers using completely different standards and each browser needed a different plug-in. However, it is expected in the new generation of HTML standards that vector graphics will be included as an integrated component, which means that different Internet-browsers will support it without needing a plug-in.
- These maps and layers are generated locally when new updates occur using a GIS program, in this case Arc View or AutoCAD MAP. Then these layers are uploaded to the server to be available online for all the users.

The third mode in NBS information-platform is the office area. The office area is considered as a virtual work place. In this area, authorized users from the project group were able to coordinate the project report in a collaborative manner. In addition, members of the project group and the steering committee were invited to follow up the process and to comment on the report during the different stages of documentation. In addition to the possibility to upload and view documents, there is a function to comment on the available documents. The authors of different documents as well as other participants are able to view and discuss the earlier posted comment.

List, upload, and view documents

Add or edit a note related to an existing document

Fig. 6-31 The office area in NBS information platform

The process of documentation in NBS continued for several months during the documentation phase of the project. This virtual office has proved to be efficient regarding time and costs of producing documents. Two critical issues were noticed in dealing with this virtual workplace. First, as there is no time needed for printing and circulating the documents, different authors tended to upload their documents at the last moment before a meeting, leaving no time for others to review the documents. The second issue is that, in many cases, the users used to print all documents and then read them. It means that this actor will not be able to follow up all the changes and updates or he will need to reprint all documents.

6.3.5. Implementation of NBS information platform

After the conceptualization and development phases that took place in March and April 2001. Four main stages could be distinguished in respect to the information platform. Each of these stages is discussed here below regarding the objectives, the organization and the observations.

Stage 1: The overview

The first stage was mainly concerned with creating the overview about inner development potentials in Stuttgart.

This stage was organized in the form of crash sessions in three days using two stations for input. District planners and some surveyors from each of the four planning departments were invited sequentially to input their information.

By observing this stage, several aspects could be concluded in respect to the information.

- Information about inner development potentials in Stuttgart is fragmented. During these sessions, it was evident that no one has a comprehensive overview about inner development potentials in Stuttgart. Even on the district level for many district planners.

- The information is implicit. Each person has a part of the knowledge in his memory but no one has the full knowledge. It was essential to convert this knowledge to be explicit so that the accumulation of this information and knowledge leads to creating the overview. For example, through discussions, new areas were identified that were not considered as potentials at first glance. This could be attributed to several reasons. The first reason is the lack of information. This case was apparent in areas where production or services were still active but are planned to be shut down in few months. A different reason is the image of a specific area especially in areas where development was blocked for long time. To overcome such a situation different types of motivation and stimulation are needed.
- To a large extent, qualitative information is subjective and is based on the individual judgment of different persons. An example of this type of information, is describing the site quality of a specific area. Such a qualitative judgment could be extremely different. Hence, a list of criteria that describe different aspects influencing this quality were used, e.g. accessibility, available utilities, etc. However, qualitative information could not be completely quantified.
- In some aspects that seemed to be objective and could be defined using a definite scale, an indirect subjective information was also included. For example, in the aspect of the availability of an area for development, the main question could be stated this way 'when an area would be available for the market?' In other words, what is the minimum time and the actions that are needed in the best case before this area would be available for the market regardless if it will be developed or not. Although the answer was simplified into the selection of one of three categories (less than one year, from 1 to 5 years or more than five years). The answer was based on the judgment of the planner, about which formal or informal processes are needed, how much time is needed for each process or which courses of actions could be followed.

From the operative technical viewpoint, most of the planners had relatively low or no idea about using the Internet in general. In addition, there was no access to the Internet in their work places. Hence, the concept of compact sessions was more efficient.

In respect to the platform design, different issues that need enhancement were identified regarding the structure of the information.

- At the first version of the system, all pieces of information were organized linearly in a single sheet, which was not efficient for entry. Therefore, the modular structure of the information was implemented as discussed earlier to improve the efficiency of using the system and to control the user access right, as not every user should have access to all the information for all areas.

- It was also clear that attempting to collect all attributes for all areas is not reasonable and is not needed. A set of basic attributes was defined that should be available for every area. The other modules of information are collected by demand.

The pattern of use in this phase, as shown in fig. 6.32 is a concentrated pattern as related to the spatial distribution of users and the distribution of the work sessions over the time.

Stage 2: Consolidation

From the implementation in the first stage, a set of critical issues and requirements were identified. Based on the results of this phase, the information platform was enhanced specially regarding the modular structure and the graphical interface.

During the stage of consolidation, members of the department of land use planning in cooperation with the district planners started to complement the information of the registered areas and to find new potentials. At this stage, they represented the indirect way for the district planners. More users have participated personally in the work at this stage relative to the earlier one. However, most of the district planners and members of other departments of the city administration were not directly using the system by themselves, they had to give the information to different members of the department of land use planning, who in turn entered these information to the platform. The problem here as mentioned earlier was the lack of access to the Internet and the lack of training.

Until this phase, most of the district planners had low or no knowledge of the Internet or online group work. It was clear that there is a need for Internet access in the work places and for capacity building. Two types of training were identified a) a general training about the Internet and, b) a specific training about the information platform. These two aspects were critical to keep the overview up-to-date.

Stage 3: Capacity building

This stage had mainly emphasized facilitating the direct access to the platform for district planners and for training them generally to use the Internet and specifically about using NBS information platform. However, regarding the operative and organizational complexities in the city administration, it took several months to arrange the Internet access and a basic training for the district planners. The indirect access to the system for the district planners before and during this phase was reflected in a stagnation phase during the fourth quarter as shown in fig. 6.32.

After arranging the direct access to the information platform, the required training took place in three cycles. The first cycle was a general introduction to the Internet, the city network and security aspects. This training was a standard course for all members of the city administration who get Internet access at their work places. The second cycle was mainly an introduction to NBS, including the information structures and functions. The main concern of most district planners in this training was about security and organizational issues such as: Where will the information be saved? Who will be allowed to see the information? Is this an additional work?

During the fifth and the sixth quarters, a low activity was observed. Few district planners have started to test and use the system while others were still in a phase of exploration. At this stage, the feedback from the planners was a base for enhancing the functionality to address the planners' needs and to give them the possibility to integrate this task in their daily work. After this enhancement, the third cycle of training took place at the end of the sixth quarter.

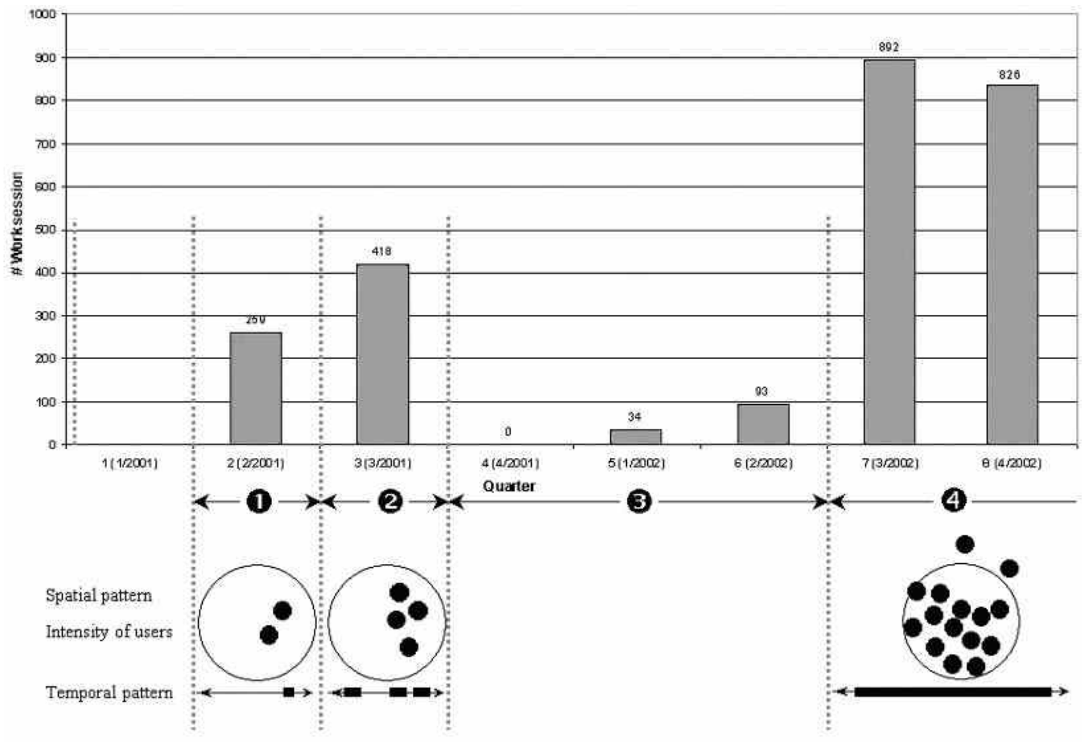
Stage 4: Implementation

After the enhancements and training at the end of the sixth quarter, most of the planners started using the system intensively to complement the information about potentials in their districts. At this phase, a very high activity was observed as shown in figure 6.32. At this stage, access to the system reached its peak. The pattern of use was spatially distributed and continuous over time. Using the system is regarded as a supporting tool for the daily work. While the main aim was to set the overview to inner development potentials, the system is used for other purposes related to promoting inner development in Stuttgart such as searching for suitable areas for specific land uses, and helping to produce marketing material for both residential and industrial areas.

The indirect effects of this process could be compared to what Innes (1999) described as: "… the 'nature of the process by which the information is produced is essential to embedding it in understandings and institutions. Information produced according to the conventional model, by presumably neutral experts who work outside and apart from the political and bureaucratic process through which policy gets made, does not become embedded in the institutions or the players' understandings. It will become "intellectual capital," or "shared knowledge", only if there is plenty of talk about the meaning of the information, its accuracy, and its implications. Information does not influence unless it represents a socially constructed and shared understanding created in the community of policy actors. If, however, the meaning does emerge through such a social process, the information changes the actors and their actions, often without applying it expressly to a specific decision." (Gruber 1994; Innes et al. 1994) (Innes 1999)

During these different stages of implementation different patterns could be identified as shown in figure 6-32 regarding the following aspects:

- Decentralization
- Integration in the daily work
- Access for all important actors



The bars illustrate the number of work sessions per quarter by all authorized users throughout the two years of the project official time. The circles beneath, illustrate the pattern of spatial distribution of users, inside and outside the city administration. The number of the black circles indicates the relative number of users. The lines at the bottom represent the time pattern of use.

Fig. 6-32 Access pattern in NBS in different phases of the project

6.3.6. Results and concluding remarks

One of the main results of the information platform is creating the overview about inner development potentials in Stuttgart.

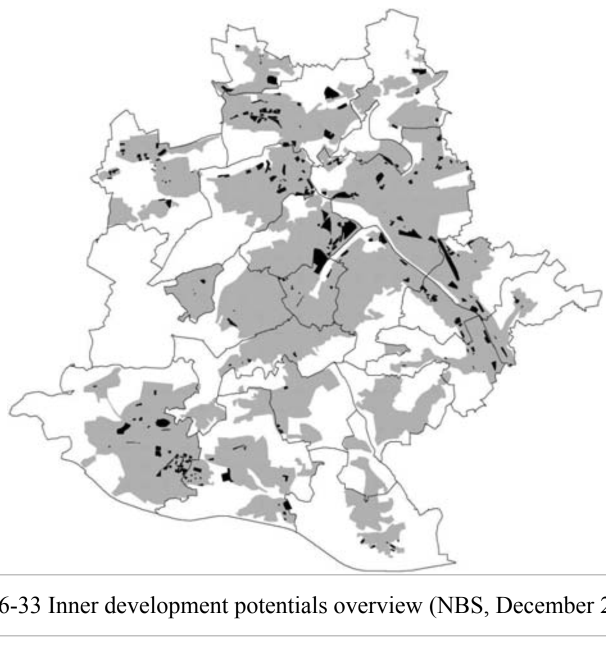


Fig. 6-33 Inner development potentials overview (NBS, December 2002)

By the end of December 2002, the system included more than 300 areas that could be used for inner development. The total area reached more than 500 Hectares. This area represents the total area needed for development in Stuttgart at least for the coming 10 years.

However, It is important to mention that creating the first overview does not mean that the task is over. It is important to consider that potentials for inner development of cities are a result of different changes in economic, social and political circumstances. These changes lead to shifts in the needs of the people and consequently reflected in the needed land uses. The importance of discussing these types of changes in relation to the development of planning information system is explained by the fact that regarding this continuous state of change in the city structure, a moment overview would be just a snapshot of a dynamic state of change, which is not enough for managing inner development of the city. In addition, distinguishing these types of changes emerges from the types of problems that are related to each type of areas. Furthermore, it will be possible for the city administration to foresee where more potential areas might be available in the future. Here is a brief discussion of some types of changes in Stuttgart with an example for each from NBS.

1. Technical and operative changes

In the last few decades, technical innovations and new organizational and economical concepts in the field of urban infrastructures lead to concentration of functions, efficient use of land, and higher productivity of each operating or production unit. Consequently leading to radical changes in the spatial structures of these infrastructure facilitates. For example, the change in the technical and operative concepts as well as the innovations in the installations of freight transportation resulted in abandoning large areas or leaving them underused in the railway and ports areas in favor of new transshipment facilities.

a. Goods railway station (Güterbahnhof – Bad Cannstadt): Changes in the operation concept of the German railways company (Deutsche Bahn AG - DB) regarding organization of goods' transshipment resulted in abandoning different conventional railway stations that do not meet the needs of modern transshipment. Among these areas in Stuttgart is this railway station in the district of Bad Cannstadt. The area of this location is 22 Hectares and is located near the Neckar River. It is easy accessible by different public transportation lines. This area is neighbored with residential areas and different sports facilities. Among the different expected problems connected with the development of this area, as well as similar areas, are soil contamination and building rests.

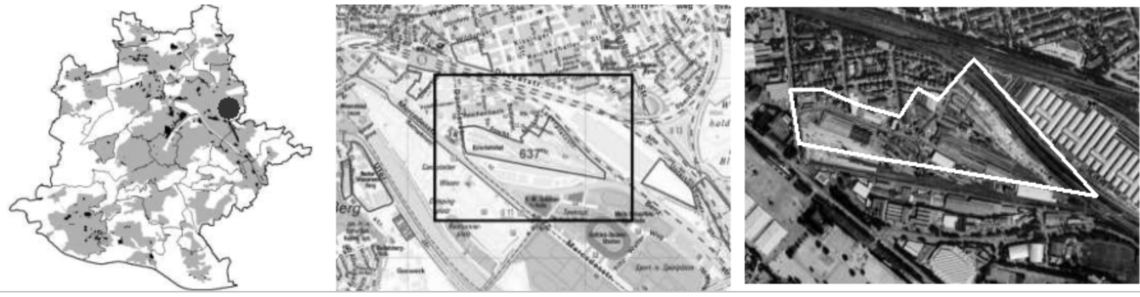


Fig. 6-34 The case of (Güterbahnhof – Bad Cannstadt)

b. Water treatment plant (Wasserwerk Areal – Ost): This area was used as the main water intake and treatment plant for Stuttgart for a long time. Since the water quality in the Neckar has deteriorated, the water corporation in Stuttgart has changed its operation concept by moving the main intake to Lake Konstans. Therefore, this area is not used any more for this function. While this area is located from the viewpoint of Stuttgart outside the major development areas, it represents a key area for developing the Neckar valley where many of the potentials exist. This area was subject to an explorative planning process during the project NBS to test different development potentials in this area and not to be limited only to the abstract level of the overview.

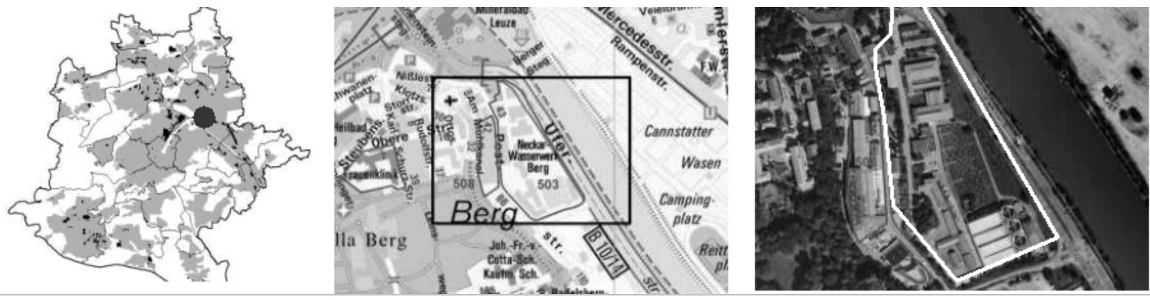


Fig. 6-35 The case of (Wasserwerk Areal – Ost)

c. The Post Area – Vahingen: this area, as the earlier areas, was abandoned from its original function as a post facility. The area is located in the district center of Möhringen. It is very well accessed by public transportation and it is near to different main roads.

Fig. 6-36 The case of (Post Area - Vahingen)

The above-described three potential areas were used for different types of infrastructure facilities and after operative or technical changes are not used any more. The common thing among all the three areas is their very good connection to public transportation and road network.

2. Economic changes

Changes in the economic structure both nationally and internationally lead to the movement of important production areas to other regions or other countries, seeking for more suitable economical incentives in the form of cheaper labor or lower taxes leaving large production areas as brown fields.

a. Vahingen industrial area: This example presents another dimension in dealing with the inner development potential, namely that in many cases potential areas could be only developed in groups and not as separate areas. This area includes different industrial areas which are abandoned due to different economic and financial reasons.

Fig. 6-37 The case of (Vahingen industrial area)

3 Urban changes

Because of the rapid urban growth of the city, different land uses that were normally on the outskirts of the city were included inside the city, e.g. the international fair area. This lead to the immigration of such land uses to new areas outside the city.

In addition, these areas, which were used for a long time for specific land uses, are considered neither efficient nor sustainable. For example, parking areas for goods conveyance that consume huge areas, which used to be on the outskirts of the city are now contained inside the urban agglomeration.

4. Political changes

Barracks area - Grenadierkaserne Zuffenhausen: This area was used as a barracks for military purposes but is not used any more. In 2002, this area was subject to development as a residential area.

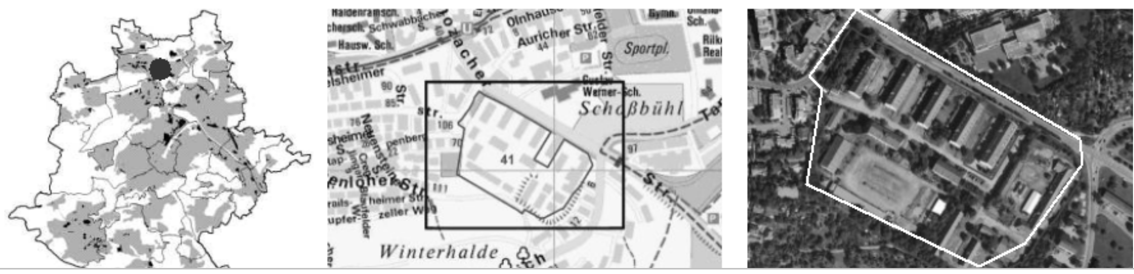


Fig. 6-38 The case of (Grenadierkaserne Zuffenhausen)

6.3.7. Concluding remarks

- From the above-mentioned examples of inner development in Stuttgart, it could be argued that the inner development potentials in a city result from different types of changes. Political, economic, technical and operational changes affect directly the patterns of land use in cities. These changes are unpredictable and their effects on the land use occur on the middle- term and on the long-term. To promote inner development, it will be essential to keep the overview to these changes, then to identify where potentials exist and to identify how these potentials should be utilized in the framework of the inner development strategy.
- The role of PIS in this case is connecting the different actors concerned, creating a common overview about these potentials, keeping this overview up-to-date and following up the process of inner development. As these potentials are in a state of change which means that areas will be developed and will be removed from the overview as potentials. Other areas will be added to the overview when they present a potential for inner development.
- This process is mainly aimed to converting fragmented and implicit information of the concerned actors to accumulative and explicit information that could serve in creating the needed overview. By doing this, the individual endeavors to document the variety of information about potential areas for development in the city has shifted to a structured process.
- The system represents a communication and consensus-building medium. By creating, opportunities for informative actions, the participating actors are to think and discuss intensively about the strategy of inner development of the city and how it could be implemented.
- To make the participation in such a process more feasible for the participating actors, information should be used in different forms that give them support in their daily work, for example, by supporting the production of marketing material about the potential areas, by facilitating site selection tasks or by supporting the district planners in producing the periodical reports about the areas in their districts.
- Because of this process, the city administration started to realize how important is it to use the Internet in the daily work of planners and other city development actors which lead to introducing Internet connection in each planning department.
- In this case, the information supply, maintenance and consumption were mainly concentrated in the formal domain of the city administration. The access and the use of information are password protected.

6.4. The case study of the "North-south Trans European railway corridor"

6.4.1. Background

The subject matter: The North-South Trans European Railway corridor (Die Nord Süd Transversale für Europe NST) extends from the North Sea to the Mediterranean Sea, from Rotterdam via Cologne – Frankfurt – Karlsruhe – Basel - Zurich – Malian to Rome (Fig. 6.39). This axis is an important corridor in the European high-speed railway network. It crosses the borders of several countries, i.e. The Netherlands, Germany, Switzerland and Italy. It also crosses the borders of Belgium and France partially.

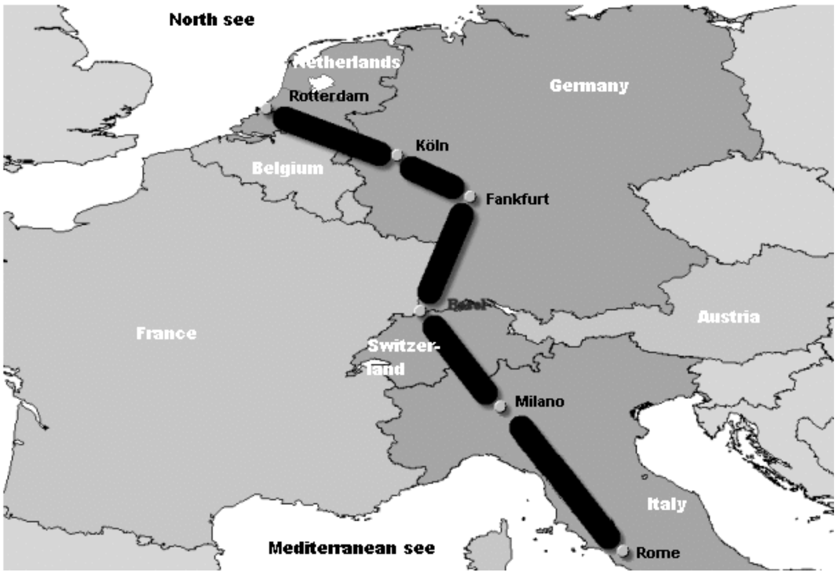


Fig. 6-39 The North South Trans European Corridor from the North see to the Mediterranean see

To explore the impact of this infrastructure development on spatial development of the regions alongside this corridor, a group of spatial planners and railway experts from different public organizations and research institutes in different European countries are working voluntarily together to create a common overview about the different aspects related to this subject. This overview is not limited to the national boarders of the individual countries. A PIS is developed in ISL by the author to support the process and to facilitate creating this overview.

Participating actors: The experts group consisted of experts from Germany and Switzerland in the first phase. It is planned to invite experts from the Netherlands and Italy in the coming phases.

The time frame: October 2002 – ongoing

6.4.2. Characteristics of the situation

The term "North South Trans European Railway corridor" describes the railway corridor that extends from Rotterdam, at the North Sea, via Cologne, Frankfurt, Karlsruhe, Basel, Zurich, Malian, and Rome to the Mediterranean Sea. This corridor represents a central north-south connection in Europe. The road alongside this corridor has been used for the movement of individuals and goods for centuries. It connects cities that have political, economic and cultural significance. This corridor represents the backbone of the European railway network and plays an important role in the transition of goods and individuals. A variety of factors governs the development of this corridor. These factors are related to the following aspects:

- The relation between infrastructure development, especially railway, and spatial development.
- Planning and realization of this corridor are conducted on different levels, from the European level to the national, the regional and the local levels. They influence the spatial development of the concerned regions and cities.
- The realization of this corridor should be coordinated beyond the borders of the individual countries and the responsibilities of the national railway authorities. These cross-border interconnections cover technical, financial and operative aspects.
- The scale of the development as a whole and as components is immense, regarding the investments and resources that are needed to realize it.
- The time lag between the planning and the realization of such development is long (up to 15-20 years or more).
- Several dynamic circumstances influence the outcomes of such a large-scale development, including: political, economic, social, operational, and technical changes.

These factors should be explored to define how they should be considered in the development and the implementation of the needed PIS. Most of these factors are discussed in section 2.3. "interconnectivities in the spatial context". Some aspects that represent special importance for this case study are discussed here below.

Railway infrastructure development and spatial development

The value of the railway infrastructure represents an enormous capital value for the countries of the European Union. A large number of these infrastructures are currently in a state of maintenance, renewal or upgrading or in need to such measures to meet the new standards of the European high-speed network. Generally, the development of technical infrastructure plays an important role in the spatial development. On one hand, it promotes spatial development by increasing the quality of life in human settlements. On the other hand, infrastructure shapes the spatial structure of these settlements for decades if not for centuries. The renewal of these infrastructure networks and facilities opens a chance for urban development in cities and towns. This chance might play an important role especially for the sites of the central railway facilities that occupy relatively large areas in the cities and influence the urban structure and the quality of life of the surrounding areas. On the contrary, the lack of coordination between infrastructure development and spatial development in these areas results in losing the opportunity for promoting inner development and might hinder further developments from the resulting restrictions of the infrastructure facilities and networks.

From the viewpoint of spatial development, planning this type of infrastructures should not only consider the direct quantitative impacts such as the travel time gain, the increasing capacity and accessibility. It should also consider the indirect demographic, economic and spatial impacts of these developments. Meanwhile, these factors affect the efficiency and the success of these infrastructure developments.

The area around this corridor has a relative importance in the EU regarding both demographic and economic aspects. Demographically, the population density in the region around the corridor presents one of the highest population concentrations in the EU, as shown in the figure 6.40. The total population in this region is estimated to range from 40-60 Million inhabitants. It is one of the most productive regions in Europe as measured by the total GDP. It presents the major region in the ratio of the GDP from research and high technology.

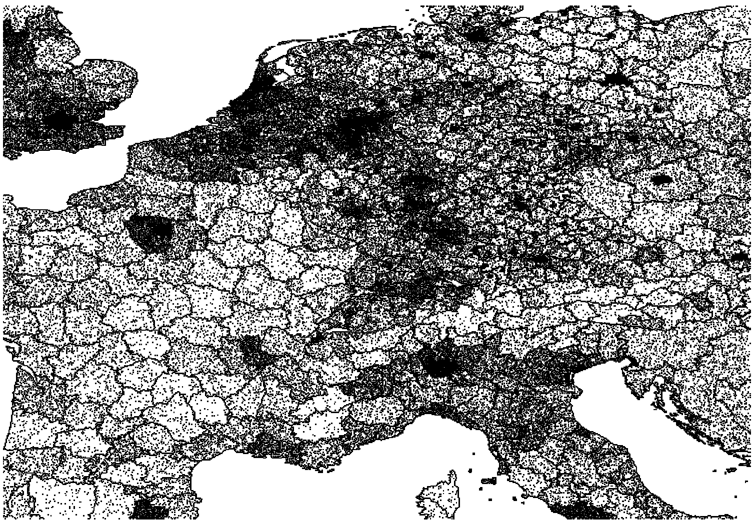


Fig. 6-40 Population density in Europe (year 2000)

The cross border interconnectivities

Although the European internal market is realized in many aspects, the railway network in the European Union (EU) is a mixture of different technical standards regarding traffic, signals, safety, and electricity systems. This could be explained since the national railway networks were mainly developed to fulfill the national needs of the individual countries at the times where the national economies of these countries were almost independent from one another.

To study infrastructure development in this corridor and spatial development, several levels of interconnectivities should be observed. On the first level of observation, there is the interconnectivity between the European priorities and the national priorities. On a different level of observation, there are the priorities of neighboring countries that are not always in harmony especially regarding specific cross-border connections. This difference in national priorities leads to the existence of bottlenecks in the network especially on the border regions. On the national level of the concerned countries, there is the interconnectivity between the national, regional and local levels. These interconnectivities play an important role in spatial planning as discussed earlier in chapter 2.

The European dimension

The policy of the European union has considered the realization of the free movement of labor, goods, services and capital as a major goal in the common European strategy. To achieve this freedom, major emphasis is given to the elimination of customs, duties and similar taxes. However, in order to facilitate these freedoms, the efficiently functioning transportation network is essential. Physical restrictions should be eliminated. Loyola de Palacio, the Vice-president of the European Commission and Commissioner for Energy and Transport (2002) stated that: "Freedom of movement for people and goods depends not just on the opening of transport markets but also on physical infrastructures. By promoting the construction of infrastructures that cross borders and connect national networks, the trans-European transport network accelerates the establishment of the internal market, links peripheral regions to the heart of the European Union and opens Europe to neighboring countries"

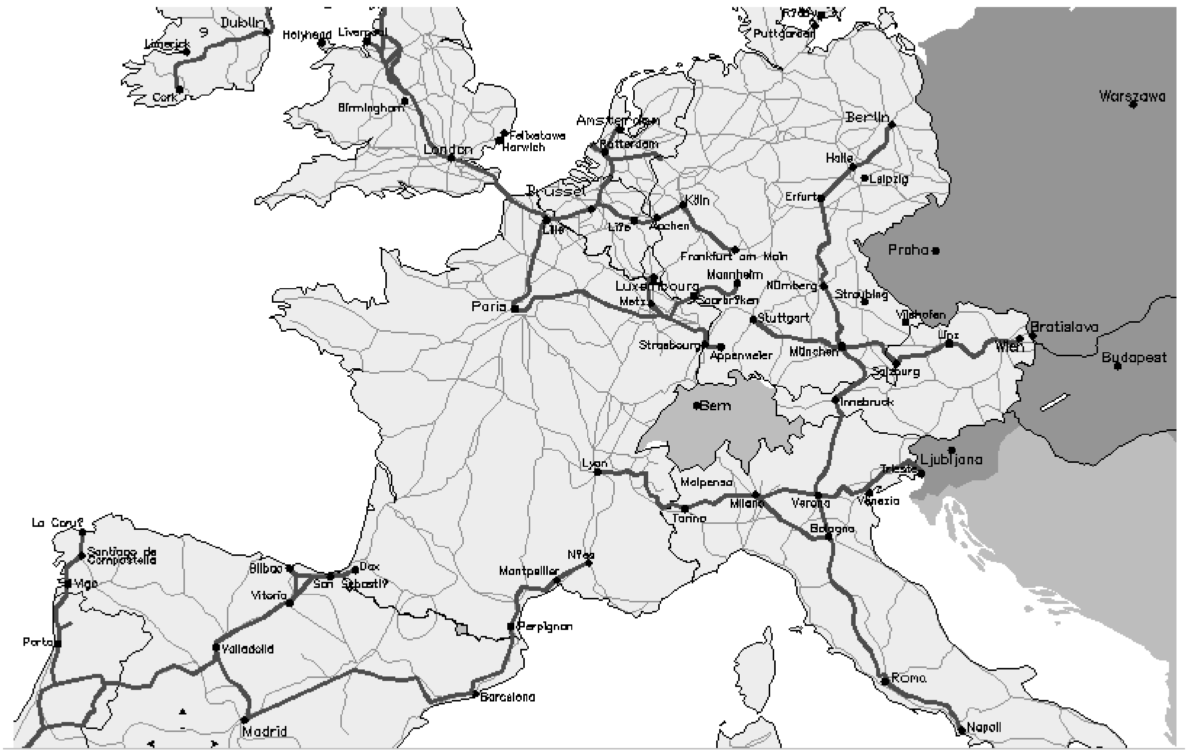


Fig. 6-41 Trans-European Transport Network Priority Projects

Source: European Commission, 2002

To achieve this goal, the European union promotes different projects for upgrading the railway networks adopted by the EU inside its territory, The Trans European Network priority projects (TEN) or networks that connect the EU to the Eastern part of Europe (Helsinki-Corridors).

Although these arguments are applied to all modes of transportation, the railway transportation is argued to be in need to more attention as the other transportation modes, i.e. road and air transportation, are expected to reach the limits of their capacity or the limits of the social acceptance for their side effects in the near future (Scholl 1999). However, the public investment in transportation infrastructure in the countries of the EU fell from 1.5 % of GDP in the 1980s to less than 1 % in the 1990s. Since 1996 when the EU has adopted the TEN priority projects, only 20 % of the planned development has been realized. It is estimated that at the current rate, the work planned for the year 2010 will need further 20 years. This delay has major impacts on the whole system and especially on the cross-border projects. While the development of the transport infrastructure is getting slower, the traffic amounts are expected to increase by 38 % in freight traffic and 24 % in passenger journeys by the year 2010 compared with 1998. This estimated traffic increase is the result of the expected economic growth. The European Commission (2001) has estimated that the road freight will rise by 50% if a major effort to rebalance traffic growth is not conducted (EC 2002).

It is expected that the transit freight traffic alongside this corridor will increase by completing the two Alpine tunnels in Lötschberg 2006-2008 and Gotthard 2010-2012 and the opening of the new projects in Rotterdam region. These projects open the chance for creating a high performance corridor from the North Sea to the Mediterranean Sea. However, some important segments of this corridor are not complete and have got less priority compared to other projects in other regions. This might affect the quality of the railway transportation alongside this corridor that consequently could result in negative economic impacts on the cities and agglomerations alongside this corridor.

6.4.3. Application of PIS

The need for PIS: To support the work of the expert group a planning information system is proposed and developed in ISL. The proposed system should deal with the three information domains that were discussed earlier, i.e. the subject-matter domain, the planning knowledge domain and the process domain.

- In the subject-matter domain:
    - It should facilitate creating the overview about the different components of this corridor. This overview is needed to identify where bottlenecks exist or might exist in the future if specific projects are delayed or not realized.
    - Several problem spaces should be observed. For each problem space, different actors are active and are conducting different planning and development activities.

- In the process domain, the system should support the process organization among the participating actors. Each actor should have access to the organizational information with a minimum effort.
- In the planning knowledge domain, it should interconnect different materials about planning laws in the concerned countries, about the different adopted plans and the norms and standard related to the railway development.

Development criteria:

In this case, study, a large number of classes of objects are included in the system. It is expected that new classes could be added during the process. Hence, one of the main objectives of this case study, in respect to the development of PIS, is the identification of the information object that could be defined as building blocks that could be reused in different situations. Similarly, it is important to define the tasks that could be defined in the form of routines. A routine task is defined in this context as a task that is frequently repeated and has a clear description of the functions, the methods and the rules that are needed to conduct this task. Therefore, a different approach is used in this case to design, develop and implement the main components of the system and the relation among these components. However, the general structure of this system consists of the same components as discussed earlier in the general structure of PIS and as implemented in the earlier cases, namely the information space, the functions, the rules scheme and the user interface.

Principally, based on the afore mentioned characteristics of the situation and the goals of the proposed system, the same general development criteria of PIS, regarding the system structure and the information organization are applied in this case.

- Regarding the system structure the following criteria are primary:
  - Decentralized and interconnected system: different participating actors are spatially distributed. They should be able to access independent from time and place. They should also be able to use different functions of the system without the support from a central administrator.
  - Open system: the system should accept input from other information sources, such as other databases and GIS. This aspect is important to make use of the already available information.
  - The system should efficiently be operating with a small set of information classes. Then it should be possible to be extended by adding new functions and classes of information according to the evolving requirements. In addition, the system should support updating existing information.
- In respect to the information organization the following criteria are important:

* Modular structure of information: the information should be modularly organized to facilitate observing the same element in different contexts.
* Hierarchical organization of information: The information should be hierarchically organized to deal with the different levels of observations. a) The first level of observation is the overview level, where the whole system is observed. This level deals with functional sections of the system. b) Each section connects two main nods. These sections are not limited by the national borders. Each of these sections includes different modules. These modules are considered the building blocks of the system. Each module has different status of realization or specific requirements to be realized. c) In addition, there are different focus points where further exploration is essential to clear the situation. These different levels should be interconnected and hierarchically linked.
* Associative organization of information is needed to illustrate the hierarchy of relations between the different levels of observation. It is also needed to illustrate the relation among different interrelated objects.

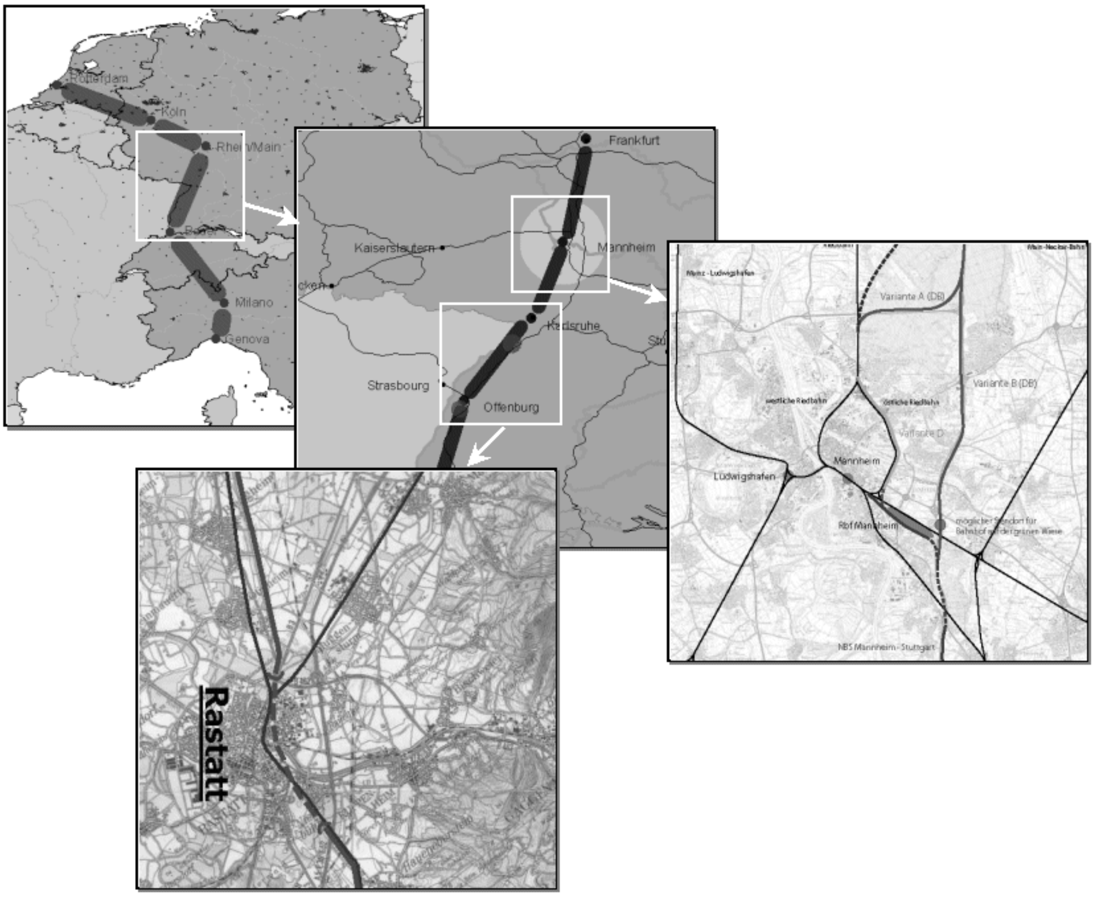


Fig. 6-42 Hierarchical structure of information in the case of NST

From the following matrix, that concludes the development criteria and the extent of each of them in this case, it is clear that the requirements in this case are high.

Criteria	Degree							
	Min.	←					→	Max.
Time span	Short						✔	Long
Open to other Info. Sys.	Closed					✔		Open
# of users	Low			✔				High
The information								
Distribution of Supply	Central						✔	Distributed
Distribution of Access	Limited						✔	Distributed
# of classes of objects	Limited						✔	Large
Dynamism of content	Static						✔	Dynamic
Types of media	Alphanumeric						✔	Multimedia
The rules scheme								
Differentiation of users	Low			✔				High
The functions								
Database management							✔	
File management							✔	
Argumentation							✔	

Table 6-5 The matrix of development criteria of the proposed PIS in the case of NST

Main components of the propose PIS:

The information space

The definition of the information objects in this case is based on a different approach for class definition and implementation. While in the earlier cases each class of objects was separately developed, in this case the three-step process that is discussed in section 5.4.1, is applied. This approach represents a more cohesive approach. The following figure 6.43 illustrates these three steps.

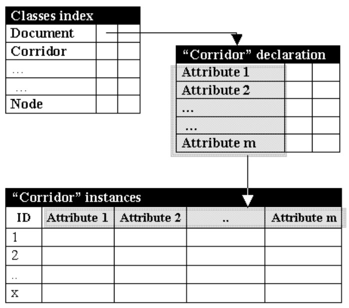


Fig. 6-43 The concept of object oriented information structure

These three steps are:

- The first step is the class registration. All classes of information objects are registered in a class registration table.
- The second step in this process is the class definition. Each class is defined using a set of attributes and relations that are used to describe the instance of this class. For the definition of each class, all attributes and relations are registered in a class declaration table. For each

attribute, this table includes the declaration rules that govern the use of this attribute. These rules include the type, the value span and the multiplicity of this attribute.

- The third step is the production of objects as instances of different classes. To produce an instance of a class, a new record is added to the corresponding class instance table. This step is repeated whenever an object is created.

Objects from the three domains of information are described using this process. In the subject matter domain a set of classes of objects such as ‘COUNTRY’,‘CORRIDOR’, ‘MODULE’, ‘PATH’, ‘NODE’ and ‘THEME’. The relation between these objects is illustrated in the following figure 6.44. This figure illustrates the concept of modularity, hierarchy and association.

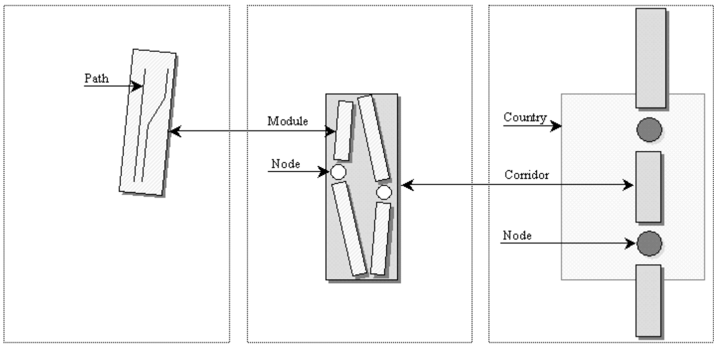


Fig. 6-44 The relation between the set of objects in the case study of NST in different levels of abstraction

In the process domain, a variety of classes are defined such as ‘PERSON’, ‘EVENT’, ‘AGENDA’, ‘PROTOCOL’, etc. in the knowledge domain ‘DOCUMENT’ and ‘LINK’ are the main classes of information objects that are used in this domain. In this case, the class of ‘DOCUMENT’ is also defined using the same concept as a class of objects with an extra attribute that defines the location of the document.

Using this concept, the class definition is encapsulated and separated from the content of the objects and their representation. This concept facilitates creating a library of classes of information objects that could be reused in different applications or as a base for creating sub classes of an exiting class. This library represents a collection of building blocks that could be combined in different configurations to produce different products. However, these objects should not be used in all situations without evaluation if the class definition and the set of attributes and relations are suitable for the current context. Otherwise, modifications or extensions should be applied.

The functions

Similar to the definition of reusable classes of information objects, different routines could also be defined as reusable functions. These functions could be encapsulated and used in different applications. These functions include the following groups:

- Primary functions for handling a single object or an instant of a class by creation, modification, representation or destruction.
- Secondary functions for handling a set of object such as listing, sorting and searching.
- File management functions.
- Visualization and layer control.
- Argumentation and discussion functions.
- Coordination and Communication

All these functions are modularly organized and could be used with different classes of objects according to the declaration rules of each function.

The rules scheme

Using the modular structure of the functions and the information objects, the rules scheme could be defined in a way that gives each user access to specific functions only for specific classes of objects. While this concept is useful in the cases where a limited number of users are using the system with a variety of access rights, it might be complex to administrate a system where a large number of users are using the system. In this case, different groups of users who have similar access rights could be defined. Then, each user gets the access rights of the group in which he is a member. In addition, for specific users specific access rights might be individually added.

	New	**Edit**	**Delete**	**Search**
Class 1	✔	✕	✕	✔
Class 2	✕	✕	✕	✔
….	✔	✔	✕	✔
….	✕	✕	✕	✔
Class n	✕	✕	✕	✔

Fig. 6-45 The access rights matrix for a user

The user interface

The user interface consists in this case of two main areas: the navigation bar and the information area. In the navigation bar, the user gets access only to the functions he is allowed to use. For each function, the classes that the user is allowed to access are listed. For example, if a user has only the right to add new documents but has no right to add new objects in the other class, he will get under the function "NEW" only the classes which he has access to. If a user has no access to a specific function, it will not be showed in the navigation bar. The navigation bar is also used to save the user's access rights and preferences in a hidden form. When the user attempts to make an action, his access rights will be checked, to figure out if he has enough access rights to conduct this action.

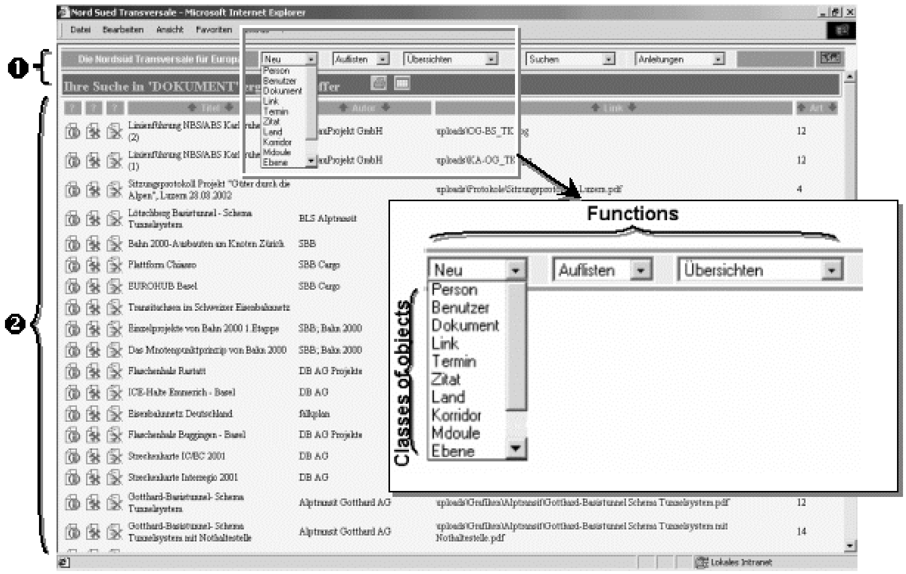


Fig. 6-46 The user interface
1. The navigation bar 2. The information area

From the experience collected in the earlier cases, it was evident that specific components of the user interface are repeated systematically during the development process for each class of objects. For example, for each class of objects, a set of forms to conduct the primary information functions is needed to create, to modify, to view or to delete an instance of a class of objects. Another set of secondary function is needed for tasks such as searching, listing, sorting a set of objects from a class. By including specific attributes in the class definition that describes how this attribute should be represented, it will be possible using server side scripts to produce the needed forms without the need to develop a set of forms for each class of objects.

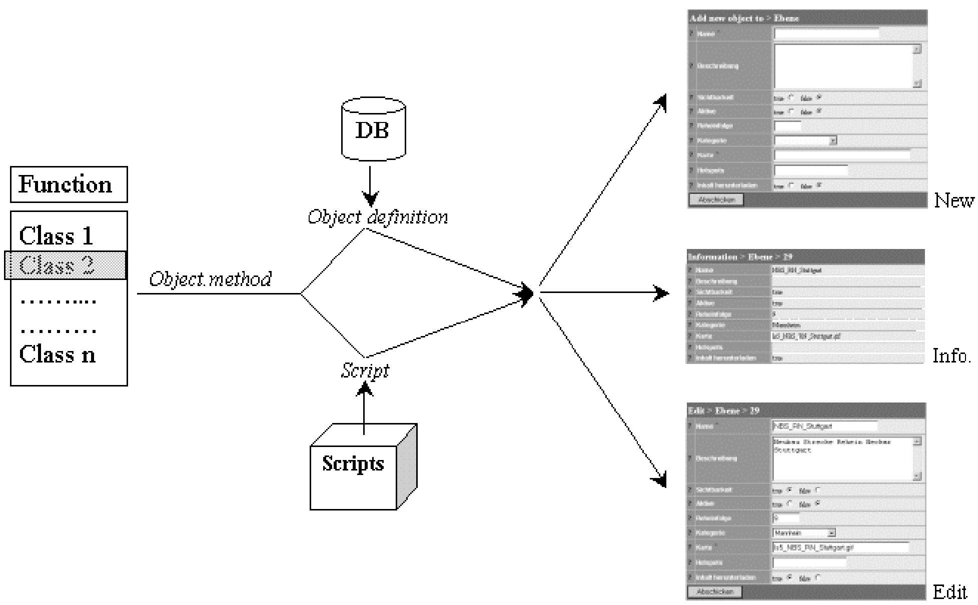


Fig. 6-47 the concept of the platform

This concept of dynamic generation of the user interface has the following advantages:

- By reducing the development effort, the user should be able to concentrate mainly on the class definition without any need to produce a separate page for each function for each object.
- This will also reduce the technical effort of preparing the user interface by automating many routine tasks.
- In addition, this concept would minimize the effort needed for maintaining the system, as the changes made in a specific attribute will be recognized in all the forms of this class. In the earlier cases where this concept was not implemented, any change must be done in all the forms of this class.

One of the most important functions in the user interface is the spatial overview. Contrary to the other cases, this case has several problem spaces. It has also different levels of abstraction. Hence, several overviews are needed to deal with these different subjects. In this case, the concept of layer sets is used to create different overviews. Each overview consists of a group of layers. The concept of "LAYER SET" is discussed in details in section 5.4.1. A list of available overviews allows the user to select the one that represents the space and the level of detail that he would like to explore.

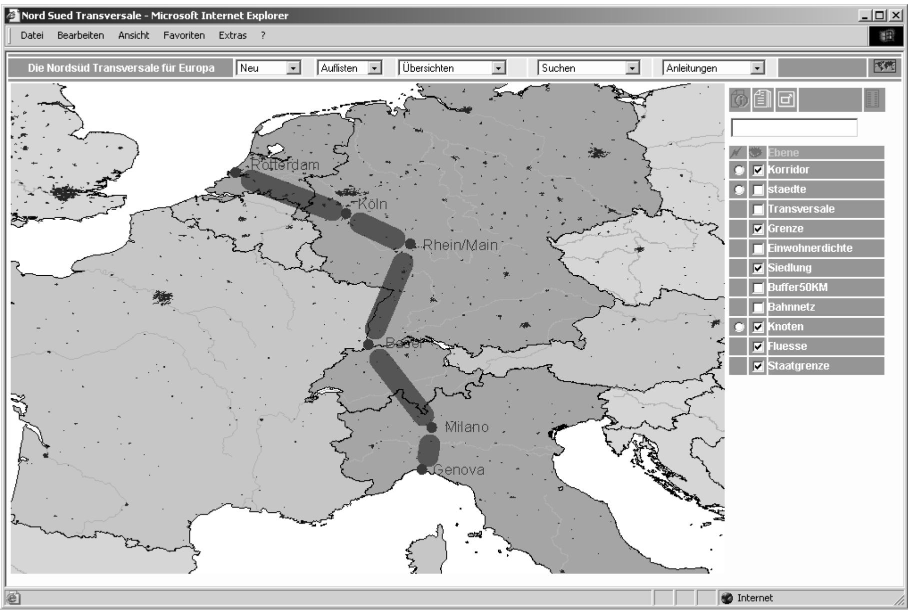


Fig. 6-48 The graphical interface

When the user selects an overview, the information area will be divided into two areas, the map area and the layer control area. Using this control area, the user can control the visibility or the activity of a specific layer. By activating a layer, the user will get different functions:

- Explore the information of the elements in the active layer. By clicking on the element, the information of this element will be displayed.
- Call all documents linked to a specific object in the active map.
- Jump to a detailed overview that deals with a specific area or subject to explore one theme at a time.

- The user can also call up all objects in the active layer in a tabular form. He can then use the normal functions in the list view such as edit, view or delete. From the tabular information, he can export the results from the table to different standard formats to use them in different programs outside the system.
- The user can toggle from the tabular and the graphical modes by a single click.

6.4.4. Concluding remarks

- This case study deals with a planning subject on a trans-national level in the European context. It deals with an infrastructure development that goes across the borders of several countries. The planning process in this case study is an ad hoc organization. The proposed PIS is aimed at supporting different information processes in the three information domains.
- In respect to the development of PIS, this case is the most recent in all the four cases that are discussed in this chapter. It was possible in this case to conclude all the results from the earlier cases to develop both the conceptual and the technical bases of the system.
  - One of the main results of this case study, in respect to the realization of PIS, is the identification of tasks and functions that are often repeated in different cases. These tasks could be dealt with as routines. This will help the users to concentrate on the class definition and not to waste time to create the forms needed to conduct the different functions. This will also guarantee that any changes in the definitions will be immediately updated in all functions.
  - In this case, it was possible to implement the concept of repertoire of the main classes of objects that are used frequently in different applications. Each of these classes of objects is defined by means of a set of attributes and the functions that are used to manipulate them. This allows reusing these standard objects and functions in different situations. It also allows developing new classes of objects with a minimum effort.
  - The used concept in this case for the definition and implementation of the classes of objects minimizes the time and the effort needed for repeating routine tasks. By selecting the modules available in the library, it is possible to start new applications.

6.5. Conclusion

- In this chapter, a variety of application case studies are discusses. These cases cover a variety of planning situations on different levels of planning from the trans national level to the city level. Each case is dealing with a different type of planning situations. In all these cases, some sort of collaborative process is essential.
- In the application case studies that are introduced in this research, main emphasize was given to supporting: exploring spatial problem, collaborative exploration of solution alternative of spatial problems, sharing planning knowledge, communication, coordination, and

documentation in collaborative planning processes. More investigation is needed about the application of PIS in supporting decision-making and argumentation.

- The requirements of PIS are directly related to the physical, technical and formal circumstances that influence the situation for which the PIS will be developed and implemented. Attempting to use the same system for all situations is not reasonable. In each situation the characteristics of the subject or the problem of the planning situation, the characteristics of the planning process that is needed to handle the subject and the characteristics of the planning information that are needed to deal with that subject and to run the planning process.
- From the technical viewpoint:
    - The use of information objects as the building blocks for such systems facilitates creating some sort of a library of objects that could be used, modified and extended in different cases. These information objects are defined regarding their attributes and relations.
    - In different cases of implementation, it is evident that specific functions are needed frequently. Hence, developing a library of functions and tools that are modularly organized facilitates efficient implementation and modification in other cases.
    - The modular organization of information and functions facilitates administering the system by giving each user the needed access to specific functions and specific objects.
    - Using simple and clear declaration rules for the information objects allows using these objects in different applications with a minimum effort to customize them.
    - By using extended declaration rules that go beyond the content of the information objects to cover representation and processing aspects, it is possible to use simple scripts to make all repetitive tasks which needed previously a lot of time and effort, for example preparing the web page that is needed for making the basic information processing tasks.
    - By using the hierarchical and associative organization of information, it is possible to explore the planning subject in different levels of abstraction and then exploring more details in specific focus points.
    - By separating the content of the information objects from the representation, it is possible to represent the same content in different contexts and representations the thing, which allows exploring the same subject from different viewpoints.
- The concept of the open system is essential in such applications. An open system supports the exchange of information with other information systems that are used by different actors.
- Such systems should be developed in a way that allows using the system with a core of information objects and functions and extending these objects and functions according to the requirements and dynamics of the process.

7. A Framework for PIS Application

This chapter aims at sketching a framework for the development of PIS in collaborative spatial planning processes. Bearing in mind the specific characteristics that should be considered in each planning situation on one hand, and the rapidly evolution in the field of information and communication technology on the other, the intention of this framework is not to introduce a technical handbook or a step by step guide for this process. Main emphasize is given to the conceptual, operative and technical aspects that should be considered in developing a PIS for collaborative planning process, apart from the applied technique.

It is important at the beginning of this chapter to differentiate between three levels of PIS development processes. These three levels are: the conception, the synthesis and the prototype levels.

- The development process of a PIS should be conducted on the *conception* level when a new concept for PIS is needed to support new tasks or to meet new requirements. A conception process would be also needed to adapt to new technical and conceptual evolutions. In this process, new concepts should be discussed, new structures should be established, new components should be developed and new measures should be defined. Conception processes of PIS are usually not conducted as a part of a single spatial planning process. They require research effort that extends beyond the limits and resources of particular planning process. However, it should be directly connected to practical planning situations to apply and to examine the validity and the applicability of these concepts to practical issues.
- On the contrary, if the present concepts are applied by resembling existing structures or combining and adjusting available components and measures, then a *synthesis* process will be required. It is used to construct a customized system to meet the specific requirements in a specific process using a general concept that is applied for other situations.
- *Prototype application* would be enough for implementing a prototype PIS to support specific information tasks in a specific type of planning processes. From the viewpoint of information handling, a repetitive planning process has specific characteristics and requirements, in respect

to information handling. In this concept, a repetitive planning process is not a routine that could be automated but there are general information requirements that are valid for different cases in this class of planning tasks, for example, supporting sharing information in small work groups of planners that are conducting a short term planning task e.g. to participate in a planning competition or to prepare a test plan.

Differentiating PIS development processes to these levels is based on the tasks that should be conducted to achieve the required PIS. The types of this process are not related to the subject matter of the spatial planning task itself, to the time span of the planning process or to the number of participating actors in this process. For example, development process of a PIS, even for a simple planning situation, it requires a conception process if new structures should be discussed, new components should be developed and new measures should be defined. On the contrary, a large scale planning process might require only a synthesis process for developing a PIS, if these aspects are available and known and requires only adjustment, combination and resembling to meet the circumstances of target planning situation.

As the whole current research is considered to a large extent a conception development process for the proposed PIS, in the following sections, the discussion is devoted to the development of PIS in synthesis processes for applying the proposed concept in this research to new cases.

7.1. Outlines of the development process for a PIS

A synthesis process for the development of a PIS for a collaborative planning process would have the following main phases:

- *The orientation phase*: This phase aims at defining the system requirements according to the specific circumstances of the planning situation.
- *The planning phase*: According to the system requirement from the orientation phase, this phase aims at preparing a general layout for the proposed PIS.
- *The development phase*: This phase is organized in several cycles. In each one, a specific part of the proposed PIS is developed in a way that makes it operating independently from other parts of the system. After each development cycle, a test and consolidation cycle is organized to test the system and adapt to the feedback from the users.
- *The implementation phase*: the system should be operating partially after the first cycle of development. Each cycle of implementation is opened with an introduction or training for the target group of the system to introduce the functionalities and the information objects that are included in the new part.

The development process of PIS in a collaborative planning process has an explorative nature. Therefore, the system should be developed in an iterative manner rather than a comprehensive one.

Iterative development allows starting the implementation with a core of information and functions and then extending and modifying the system according to the evolving needs. This approach allows obtaining quick results at an early stage. On the contrary, a comprehensive approach requires a well-structured problem definition and longer time to produce results. The following figure (7.1) illustrates a typical outline of a PIS development process in a collaborative spatial planning process. The illustrated case is for a relatively long process (more than one year).

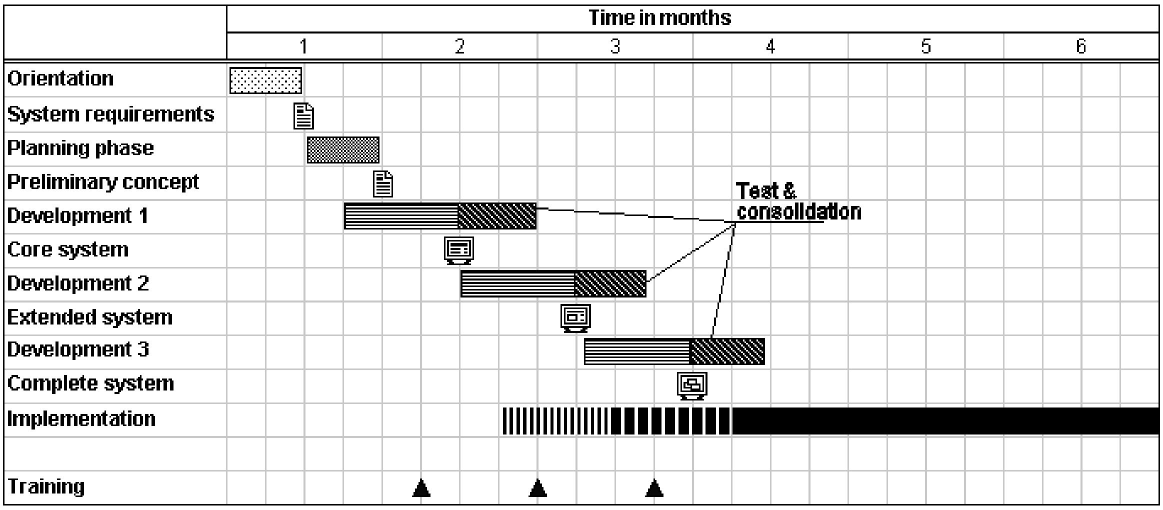


Fig. 7-1 The outline of a development process for a PIS

For a shorter process, the same main phases are comparable but in a compact form by reducing the time for each case, and by conducting less cycles in the development phase according to the requirements of the case. In such a case, the time scale is weeks and not months. Furthermore, if most of the required functionalities and the information classes are available, from earlier processes, this time could be radically reduced. This issue is discussed in the following section in details.

In the following section, each of the above-mentioned phases is described regarding the specific issues that should be considered, the tasks that should be conducted and the outcomes that are expected. To make this framework practical and to avoid replication of issues or figures that are already discussed in earlier parts, this section takes the form of a list of questions and aspects that should be handled in each phase with a reference using ➔ to indicate the section or 🗎 to indicate the figure that includes the details about each point.

7.2. Typical phases of the development process of a PIS

7.2.1. The orientation phase

As mentioned earlier, each planning situation is governed by a set of aspects that are related to: the subject matter of planning, the planning process and the planning information. In this phase, these three aspects should be explored to define the tasks of the required PIS and the main factors that should be considered in the next phases.

I. What are the main characteristics of the planning situation that needs the PIS?

a. The main characteristics of the subject matter of planning → 2.3

- What are the main interconnectivities that should be considered?
  - Concerned actors / Inter-level / Inter-regional / Cross-border / Inter-sector
- What are the main dynamics that influence the subject matter of the planning?
  - internal dynamics / external dynamics

b. The main characteristics of the planning process → 2.4

- Formal aspects:
  - What is the legal framework for the planning process?
  - Does the planning process lay in the intersections of different legal domains?
- Organizational aspects
  - Who are the participating actors in the process?
  - How is the process organized?
  - What is the time span of the planning process?
  - What are the expected outcomes of the planning process?
- Technical operative issues
  - Available technical infrastructure (networks/workstations/internet access)
  - Available information systems that should/could be interconnected to the system
  - Users' competence
  - Formal rules regarding information in general and information systems

c. The main characteristics of the planning information in the current situation → 2.5

- Types of information that should be considered, including
  - subjects and types of the needed information for conducting the planning task,
  - amount, quality and types of available information that should be integrated in the PIS,
  - sources of the needed information.

II. Based on the results of the orientation phase, what are the basic system requirements?

a. Dimensions of the required system ➔ 4.2

- Which tasks should PIS support?
  - Exploration of planning matters for situation assessment.
  - Exploration of solution directions and development of proposals.
  - Organization of information in planning processes.
  - Facilitating recalling and exchanging of planning knowledge.
  - Others.
- The time span of the process
  - Short term (3-6 months)
  - Middle term (6-12 months)
  - Long term (1-2 years)
  - Open end
- Target groups of the PIS
  - Public
  - Internal
  - Cross organizations
  - Sub groups
  - Others

b. The system requirements matrix ➔ 4.3

- The system requirements should be discussed among the concerned actors to identify the specific characteristics of the needed PIS. Beside the general requirements concerning the number of users and the time span of the system, there are specific requirements that are related to the main components of the system, namely the information space, the functions, the rules scheme and the user interface. The following table summarizes some of these requirements.

Criteria	**Scale**							
	Min.	←				→		**Max.**
Time span	Short							Long
Differentiation of user groups	Low							High
Relation to other information systems	Closed							Open
Distribution of information supply	Central							Distributed
Distribution of access to the system	Limited							Distributed
Amount of classes of information objects	Limited							Large
Dynamism of content	Static							Dynamic

Fig. 7-2 System requirements matrix

7.2.2. The planning phase of PIS

III. Based on the systems requirements from the planning phase, system structure	**➔ 4.4**
a. The information space	➔ 4.4.a

- Which information domains should be considered in the system? Is the system oriented to one or more information domains? ➔ 3.1
  - ∗ The subject matter domain
  - ∗ The process domain
  - ∗ The planning knowledge domain
- Which specific information processes should the system support? ➔ 3.2
  - ∗ Communication,
  - ∗ Coordination,
  - ∗ Decision making,
  - ∗ Argumentation,
  - ∗ Others
- What are the main classes of information objects that are needed? ➔ 3.3
  - ∗ List of classes
  - ∗ Relations between the classes (class / relation diagram) 3.23
  - ∗ The needed logical objects

b. the functions and the tools	➔ 4.4.b

- Primary & secondary database management functions
- File management
- Visualization and layer control
- Coordination, discussion, others

c. The rules scheme (Access spheres)	➔ 4.4.c

- Flat structure (workgroup)
- Two dimensional structure (public/internal, workgroup/subgroups or workgroup/individual)
- Three dimensional structure (public/internal & workgroup/subgroups/individual)
- Multi dimensional structure (Three dimensional & Access rights criteria, e.g. geographical / functional / subject specific)

d. The user interface	➔ 4.4.d

- Is there more than one user interface? (e.g. public / internal)
- What are the main components of the user interface?

7.2.3. The development phase

- The system development should be organized in a way that directly supports the planning process aiming at solving the problem.
- It should be organized in a way that allows starting the implementation with a *core PIS* that includes a set of basic objects and functions. It should be organized in *several cycles*. Each cycle is devoted to developing a specific part of the PIS according to the requirements and the priorities of the planning process.
- Organizing a repertoire of classes of objects and functions that are frequently needed in different processes would facilitate the development process. This repertoire should be organized in the form of modules that could be used with minor changes and customizations in different applications.
- The classes of objects repertoire might include the primary definition of classes such as "ACTOR", "DOCUMENT", "AREA", "PROJECT", "EVENT" that are frequently used. In addition, it could include the definition of logical objects such as "MOBILIZATION RATE", "FLOOR AREA RATIO".
- The functions' repertoire might include all the primary and secondary database management functions as well as the file management functions. These functions are required in every PIS. In addition, it may include functions such as layer control and discussion forums.

a. The system outlines → 5.3

- Definition and agreement on the technical criteria of development. → 5.3.1
- Outlines of the proposed PIS 5.9
- Definition of the needed development cycles and the main contents of each cycle.

b. The first development cycle → 5.4

- The first cycle of development should make use of the available repertoire to reach a quick start for the PIS.
  - Definition of the information objects → 5.4.1
  - The functions and the tools → 5.4.2
  - The rules scheme → 5.4.3
  - The user interface → 5.4.4

c. Test and consloidation

- After each development cycle, a test period is needed to examine the system. This test should be organized with a small test group of users. However, it should be broad and intensive enough to find out any problems before the implementation phase.
- Based on the results of each test period and on the feedback from the users, the essential adjustments in the functions and in the object definition should be done. In addition, the rules

scheme and the user interface could be modified if specific customizations are defined to be important.

d. Further development cycles

- According to the outlines of the proposed system and based on the requirements that emerge during the planning process, the PIS should be extended and enhanced in subsequent cycles of development. In each cycles new functions and tools might be added, new classes of objects might be integrated, more work modes might be introduced and new groups of users might be considered. After adding these new components, the system should be operating in a cohesive manner.
- The extensions and changes in the PIS in each development cycle should be conducted in a way that let the users be able to find the earlier components they are accustomed to use, as a reference and orientation point.

7.2.4. The implementation phase

a. Capacity building / trainning ➔ 6.3.5

- Before the implementation of the whole system as well as before implementing new parts of the system, the concepts and applications that are used should be introduced to the users.
- It is evident from the application case studies, that introduction and training are especially important for users who are not used to the concept of the proposed system. If a user is confronted with a concept that differs from his mental frames, this might lead to losing the orientation or to the emergence of a mental barrier between the user and the system.
- On the contrary, when the users get enough introduction and opportunity to experiment the system, many users have developed new ideas about extending the application of the proposed concepts to new areas, which are not included in the original system.
- It was also apparent that using guidelines and handbooks as the only method to introduce the concepts is not a substitution for the personal training and the face-to-face discussions especially when starting new systems.

b. Integration with other infomation and decision making processes

- For PIS that is planned for a large scale collaborative planning process for long time (as in the case of NBS ➔ 6.3.), the system should be integrated with other information and decision making functions of the participating actors to optimize the use of resources that is devoted to these functions.
- PIS should integrate available information from other systems, if it is needed for the systems purposes, so that the users are not overloaded with unnecessary and time-consuming work.

- It should give them support in other relevant functions, so that the PIS should be contributing in a direct benefit for each user so that he stays motivated to keep updating the information for which he is responsible.
- It is important to mention that failure of many knowledge management and information systems is a result of considering the development as a separate task that operates parallel and not integrated with the actual work.

c. Byoned the implemntation

- It is not enough to consider that the development process is over by the implementation of PIS, there is a need for a systematic follow up to observe if the system is serving the purpose for which it is aimed.
- The formalization of a PIS should be avoided. Formalization of PIS occurs through converting the information processes to a goal in itself, without evaluating if the system is supporting the decision making and leading to solving the problems, especially in long term collaborative planning processes.
- For PIS that supports spatial planning tasks that extend over long periods (more than one year), a periodical review, evaluation and upgrading cycles should be organized according to the follow-up of the implementation.
- If a PIS should be transferred to an agency or organization other than the one, which developed it, as in the case of NBS, the transfer process should be organized in an appropriate time through the process, so that the needed measures are realized before the process end. The needed measures for the transfer of such a system is not only limited to human and material resources, it might need administrative and operative measures that normally take long time especially in the public administration.
- If the PIS is designed for a specific process that has a specific time span, the system and its content should be documented by the end of the process in a way that allows recalling or reusing parts of its components and the contents in other processes or for recalling specific issues about the process.

A final remark

The technical dimension in PIS development processes should not overwhelm the whole process. It should be kept in mind through out the conception, development and implementation of PIS for collaborative spatial planning processes specially in complex spatial tasks, that the proposed system is aimed at supporting the problem solving process and should not be observed as a goal in itself.

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Kurzfassung

Planerische Informationssysteme (PIS) sind Mittel für die Steuerung und Unterstützung von verschiedenen Informationsprozessen, die in der räumlichen Planung durchgeführt werden. Wenn man PIS aufbauen und umsetzen will, sollten unterschiedliche Aspekte betrachtet werden:

* Eigenschaften der räumlichen Probleme,
* Eigenschaften des Planungsprozesses, in dem diese Probleme behandelt werden sollen, und
* Eigenschaften der Planungsinformationen, die erforderlich sind, bzw. in diesen Prozessen produziert oder verarbeitet werden.
* Diese Informationen werden von Menschen verarbeitet und produziert. Folglich sollte die Art und Weise der menschlichen Informationsverarbeitung im allgemeinen und besonders beim Planen und Entscheiden ebenfalls betrachtet werden.

Komplexe Raumplanungsaufgaben befinden sich in einem Geflecht einer Vielzahl von dynamischen Zusammenhängen, welche die Problemstellung und die Folgen der geplanten Tätigkeiten beeinflussen könnten. In solchen Situationen sind die Lösungsmöglichkeiten nicht im Voraus gegeben oder allgemein bekannt. Sie sollen erst erzeugt werden. Solche Aufgaben müssen in einem Netzwerk von Akteuren behandelt werden. Solche Probleme werden normalerweise in einem längeren Prozess behandelt, in dem mehrere Einzelpersonen oder Organisationen aus unterschiedlichen Disziplinen zusammenarbeiten sollen. In derartigen Situationen sind Informationen unvollständig und vage.

Angesichts dieser Eigenschaften einerseits und der sich schnell entwickelnden Informations- und Kommunikationstechnik andererseits, die ständig Innovationen erzeugt und neue Gelegenheiten öffnet, ist es die Aufgabe des Planers, zunächst die Anforderungen der unterschiedlichen Aufgaben der räumlichen Planung zu klären, dann die Potenziale der neuen Technologie zu erkunden und hieraus Werkzeuge zu entwickeln, die den Anforderungen solcher Situationen entsprechen. Es reicht jedoch nicht aus, neue Technologien zu verwenden, indem man traditionelle Konzepte des Gebrauches von Informationen mit einer Fassade aus neuer Technologie verkleidet (Bracken 1990). Die neue Technologie regt die Erkundung von neuen Formen der Kommunikation und neuen konzeptionellen Strukturen an, die infolgedessen zu einem effizienteren Gebrauch von Informationen führt.

So wird in dieser Dissertation argumentiert, dass der Aufbau und die Umsetzung von PIS nicht nur eine technische Aufgabe ist, die allein von Informations-Experten angegangen werden könnte. Die oben erwähnten Faktoren sollen in Aufbau und Umsetzung dieser Systeme betrachtet werden. Die Absicht dieser Abhandlung ist es, die Hauptaspekte, welche die räumliche Planung in den komplexen Situationen beeinflussen, aus planerischer Sicht herauszufinden, um anschließend die Anforderungen an ein PIS als Instrument für die Informationsverarbeitung im Planungsprozess zu definieren. Im nächsten Schritt sollen die Möglichkeiten der Anwendung der neuen Informations- und Kommunikationstechniken erforscht werden, um ein derartiges System zu verwirklichen.

Ziel dieser Arbeit ist es, einen Leitfaden für Aufbau und Umsetzung eines PIS in gemeinschaftlichen Planungsprozessen zur Behandlung von komplexen Planungsaufgaben zu entwickeln. Dieser Rahmen soll die theoretischen, konzeptionellen, technischen und operativen Aspekte beinhalten. Die Tauglichkeit des vorgeschlagenen Leitfadens wurde anhand verschiedener Planungsaufgaben in der Praxis getestet.

Die Arbeit ist in sieben Kapitel gegliedert. In erstem Kapitel wird der Begriff „Information" aus unterschiedlichen technischen und intellektuellen Perspektiven dargestellt. Dann wird eine Arbeitsdefinition des Begriffs „Information", wie sie in dieser Forschungsarbeit verwendet wird, vorgestellt. Im Anschluss daran werden die Haupteigenschaften der Informationenverarbeitung durch den Menschen zusammengestellt.

In Kapitel 2 wird argumentiert, dass die Rolle und der Gebrauch von Informationen in den verschiedenen Planungstheorien unterschiedlich ist. Folglich sollten die theoretischen Grundlagen von PIS auf folgenden Aspekten basieren: den Eigenschaften von Menschen in der Informationsverarbeitung, den Eigenschaften der räumlichen Probleme, den Eigenschaften des Planungsprozesses und den Eigenschaften der planerischen Informationen. Diese Eigenschaften sind für die Entwicklung und die Implementierung von PIS entscheidend.

Angesichts der Vielzahl der Informationsarten und Tätigkeiten, die als Informationsprozess in der räumlichen Planung betrachtet werden, umfasst Kapitel 3 einen Versuch, eine Typologie zu Planungsinformation aus unterschiedlichen Perspektiven aufzustellen. Informations-Domänen, Informations-Prozesse und Informations-Objekte sind in diesem Zusammenhang von besonderer Bedeutung für das PIS . Für die Entwicklung eines PIS ist es wesentlich, zu definieren, welche Domänen für den gegenwärtigen Fall erforderlich sind, welche Prozesse unterstützt werden sollten, und welche Informations-Objekte enthalten sein sollten.

Kapitel 4 beginnt, indem es den Begriff „System" erkundet, um die Hauptbestandteile eines Systems zu definieren. Dann werden, basierend auf den Eigenschaften, die aus Kapitel 2 resultieren und der in

Kapitel 3 entwickelten Typologie, die Hauptkriterien, die in PIS betrachtet werden sollten, bezüglich der Systemstruktur, der Systemorganisation und der Informationsorganisation definiert. Danach werden die Hauptbestandteile des vorgeschlagenen Systems eingeführt.

Wie oben erwähnt, soll die Suche nach verwendbaren Informationssystemen für gemeinschaftliche Planungsprozesse in komplizierten Situationen auf den spezifischen Anforderungen der jeweiligen Situationen basieren. Folglich ist Kapitel 5 eine Untersuchung der technischen Möglichkeiten innovativer Informations- und Kommunikationsmittel, um zu definieren, welche Techniken, aufbauend auf den Anforderungen und den konzeptionellen Kriterien aus den früheren Kapiteln, verwendet werden könnten, um das vorgeschlagene System zu realisieren. Obgleich das Spektrum der innovativen Technologien nahezu unbegrenzt ist, sollten die verwendeten Techniken in PIS einfach sein und keine speziellen Voraussetzungen erfordern. Folglich beinhaltet dieses Kapitel eine Gruppe technischer Kriterien, die betrachtet werden sollten.

Diese Untersuchung basiert auf unterschiedlichen Experimenten in einer Vielzahl von Projekten und Planungsprozessen mit besonderer Betonung auf zwei Hauptbereichen der räumlichen Planung. Der erste Bereich ist das Nachhaltigen Flächenmanagement in schnell wachsenden Städten, mit besonderem Schwerpunkt auf innerer Entwicklung. Der zweite Bereich ist der Zusammenhang zwischen Infrastrukturentwicklung und räumlicher Entwicklung. Diese Experimente werden in Kapitel 6 eingeführt. Sie umfassen verschiedne Planungsprozesse, einschließlich grenzüberschreitender, organisations-überschreitender Prozesse und der Zusammenarbeit in Ad-hoc Organisationen. Für jeden dieser Fälle wurde ein PIS entwickelt und eingeführt, jeder Fall stellt die Anwendung von PIS auf einer anderen Planungsebene dar. Basierend auf den Resultaten dieser Experimente wird der vorgeschlagene theoretische, konzeptionelle, technische und operative Leitfaden für Aufbau und Umsetzung von PIS in Kapitel 7 dargestellt.