The development of an Implementation Methodology for a Conceptual Framework Tool used for the Improved Viewing and Utilisation of Organisational Information.

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also recognise and utilise the relations that exist between the different business (and where relevant, technical) metadata. By focusing in this way on the context of information as well, more of the information processing could be performed by a tool or approach, yielding a smaller, focused, and more relevant set of information in response to an information query by a knowledge worker. The result of employing such a tool or approach in an organisation will then obviously be a reduction in the time spent by knowledge workers to assess and utilise information, and ultimately enable the organisation to become more agile and competitive.

This thesis describes a research project that focused on an approach currently being investigated at Stellenbosch University for identifying and utilising context within information. The next section will communicate the rationale behind the project, with the final section in this chapter explaining the structure of the thesis document. An image depicting the structure of this chapter is displayed in Figure 1.1.

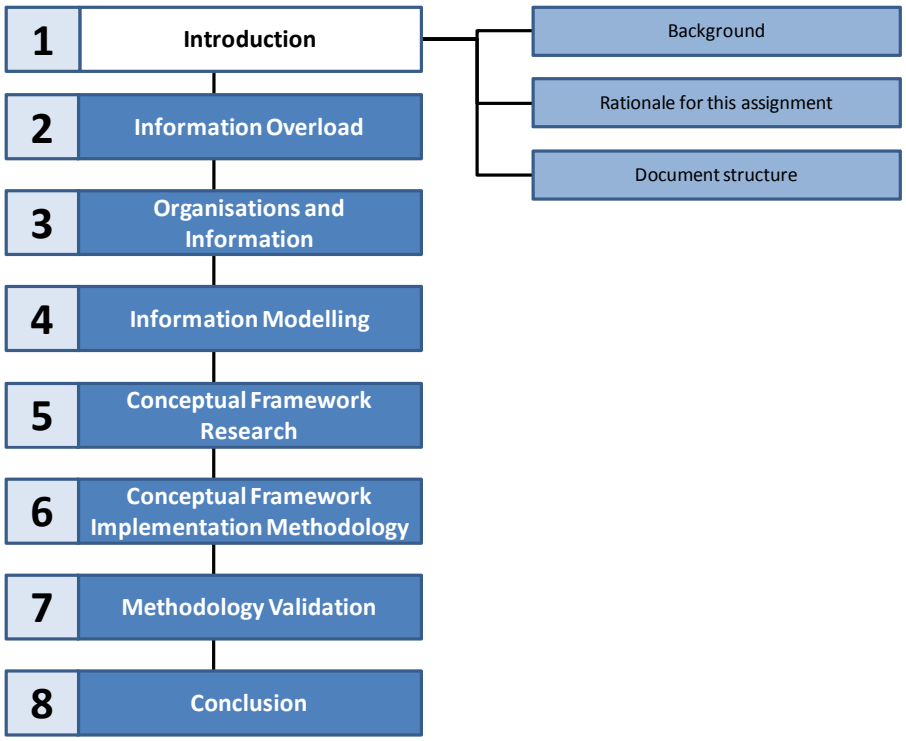


Figure 1.1: Image for navigating thesis and chapter 1

1.2 Rationale for this assignment

Research is currently being conducted on an approach developed at Stellenbosch University through which context in information can be represented in a manner that is easily understood by both humans and machines, and which is aimed at improving the manner in which information can be utilised within organisations. The approach follows the school of thought which states that information can be described

manifests itself in the ability of a person to extract the information he/she needs from the entire knowledge base within a reasonable time span.

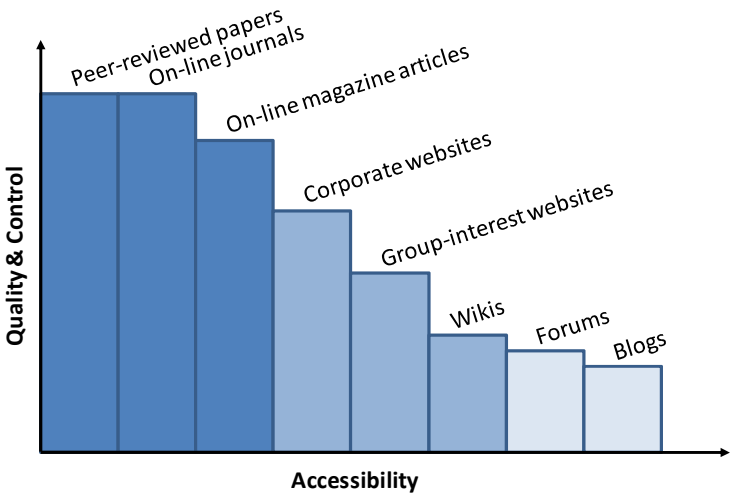


Figure 2.1: Comparison of the quality & control and accessibility of different internet information sources

This chapter (of which the structure is depicted in Figure 2.2) discusses the manner in which interaction with information takes place in the world today, and provides insight into the malady experienced by individuals and groups of individuals (like organisations) in attempting to assimilate vast quantities of information, called *information overload*. In order to impart a better understanding of this problem, causes, symptoms and proposed solutions to the information overload problem will specifically be discussed.

2.2 Available information and rate of information creation

The increase in the generation and availability of information has become ever more apparent over the last few decades as the following quotes clearly indicate:

- 'As we go from grade school to high school we learn only a billionth of what there is to learn. There is enough scientific information written every day to fill seven complete sets of Encyclopedia Britannica; there is enough scientific information written every year to keep a person busy reading day and night for 460 years!' (Siegel cited in Information Overload Statistics 2003)
- 'The daily New York Times now contains more information that the 17th century man or woman would have encountered in a lifetime.' (Wurman cited in Information Overload Statistics 2003)

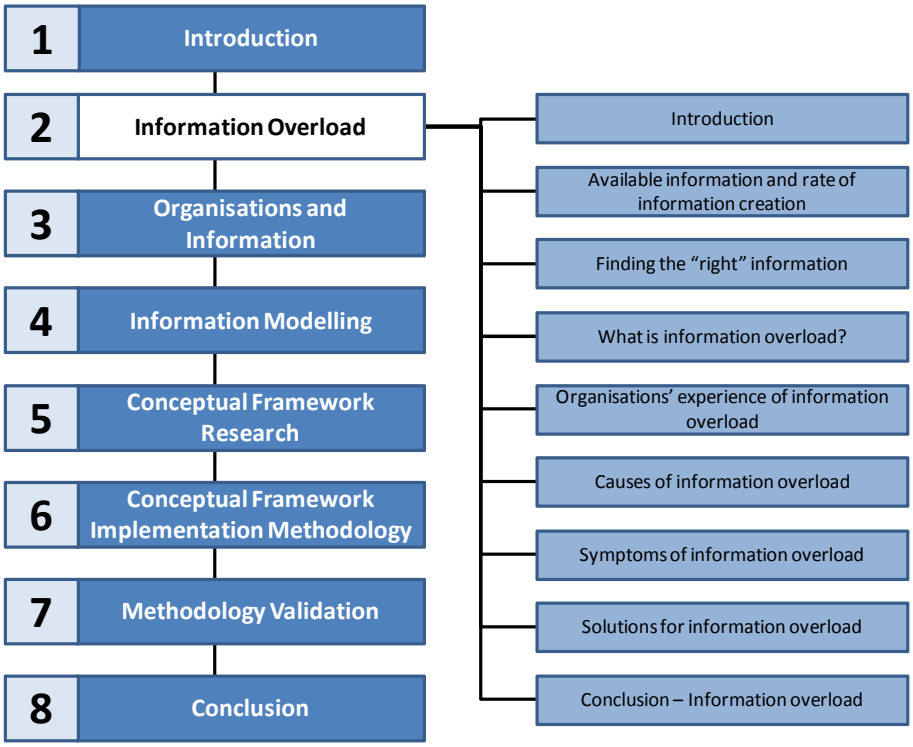


Figure 2.2: Image for navigating thesis and chapter 2

- 'About 1,000 books are published internationally every day, and the total of all printed knowledge doubles every five years.' (Information Overload Causes Stress cited in Information Overload Statistics 2003)
- 'The average Fortune 1000 worker already is sending and receiving approximately 178 messages and documents each day, according to a recent study, "Managing Corporate Communications in the Information Age."' (Boles cited in Information Overload Statistics 2003)
- 'Dr Dharma Singh Khalsa, in his book Brain Longevity,...says the average American sees 16,000 advertisements, logos, and labels in a day.' (Gore cited in Information Overload Statistics 2003)

The University of California Berkeley conducts a project named 'How Much Information', which studies the amount of information produced each year in the world (*How much Information?* 2003), and how that information is utilised by the world's population. Here are some of the findings from the study conducted in 2003:

- ***The (size of the) INTERNET***

  Although the Internet is the newest medium for information flows, it is the fastest growing new medium of all time, and becoming the information medium of first resort for its users. Note that the Web consists of the surface web (fixed web pages) and what Bright Planet calls the deep web (the

database driven websites that create web pages on demand). Table 2.1 shows the estimated size of the different aspects of the Internet:

Table 2.1: The size of the Internet in terabytes (Source: How much information? 2003)

Year: 2002	Terabytes[1]
Surface Web	167
Deep Web	91,850
Email (originals)	440,606
Instant messaging	274
TOTAL	**532,897**

- ## *Amount of information produced per year*

Print, film, magnetic, and optical storage media produced about **5 exabytes**[2] of new information in 2002. 92% of the new information was stored on magnetic media, mostly in hard disks.

- ## *Flow of information*

Information flowing through electronic channels – telephone, radio, TV, and the Internet – contained almost **18 exabytes** of new information in 2002, three and a half times more than is recorded in storage media. 98% of this total is the information sent and received in telephone calls – including both voice and data on both fixed lines and wireless.

- ## *How many web searches are conducted per day?*

According to SearchEngineWatch.com, as of January 2003, there were 319 million searches performed per day by the major search engines. This figure is calculated using the Nielsen/NetRatings "search hours"; the total time spent by all visitors searching at each engine. Table 2.2 shows search statistics per search engine:

[1] *1 terabyte* = 10^{12} *bytes*
= *1,000 gigabytes*

[2] *1 exabyte* = 10^{18} *bytes*
= *1,000,000,000 gigabytes*

5 exabytes = *All words ever spoken by human beings. (Source: How much information? 2003)*

Table 2.2: Search statistics per search engine (Source: How much information? 2003)

Search engine	Search hours per month (in millions)	Search minutes per day (in millions)	Searches per day (in millions)
Google	18.7	37	112
AOL Search	15.5	31	93
Yahoo	7.1	14	42
MSN Search	5.4	11	32
Ask Jeeves	2.3	5	14
InfoSpace	1.1	2	7
AltaVista	0.8	2	5
Overture	0.8	2	5
Netscape	0.7	1	4
Earthlink	0.4	1	3
Looksmart	0.2	0	1
Lycos	0.2	0	1
TOTALS	**53.2**	**106**	**319**

- ***How many hours do individuals spend online?***

  The average global Internet user spends 11 hours and 24 minutes online per month, according to Nielsen/NetRatings. The average user in the United States spends more than twice that amount of time online: on average, 25 hours and 25 minutes at home and 74 hours and 26 minutes at work.

It can be seen that information is definitely not scarce, and new information is clearly also being generated and renewed at an astounding rate, as new technologies like hand-held PCs make the generation of information (often by untrained users) increasingly simpler (Paes 1994). It is further clear that people realise that the information they seek can be found on the Internet, and therefore spend large amounts of time searching for it. The problem is that there currently exists too much information on most topics for any person to review, organise or even just to absorb. Instead of being starved for information, we find ourselves overloaded (Borchers et al. 1998).

2.3 Finding the "right" information

Because of the overabundance of information in the world, finding any information on a certain topic is very little trouble. In some cases systems (like computer-mediated communication systems or CMCS's) have been employed to push information to users, negating the need to go look for information. Based on a number of user-defined criteria, these systems scour the Internet, finding information coinciding with the criteria, and pushing it to the user. If the user however does not require this information at a specific point in time, he/she may be flooded very rapidly with superfluous information if it does not fit the situation in which the user currently finds him/herself (Hiltz & Turoff 1985). In most cases, the need for certain

'Researchers across various disciplines have found that the performance (i.e., the quality of decisions or reasoning in general) of an individual correlates positively with the amount of information he or she receives — up to a certain point. If further information is provided beyond this point, the performance of the individual will rapidly decline (Chewning & Harrell, cited in Eppler & Mengis 2004). The information provided beyond this point will no longer be integrated into the decision-making process and information overload will be the result (O'Reilly, cited in Eppler & Mengis 2004). The burden of a heavy information load will confuse the individual, affect his or her ability to set priorities, and make prior information harder to recall (Schick et al., cited in Eppler & Mengis 2004). Figure 2.3 provides a schematic version of this discovery. It is generally referred to as the inverted U-curve, following the initial work of Schroder, Driver, and Streufert' (Schroder et al, cited in Eppler & Mengis 2004).

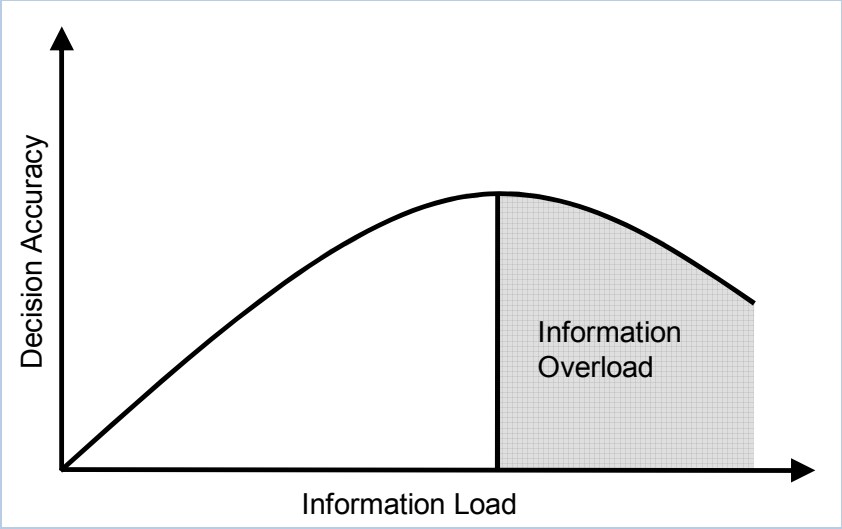


Figure 2.3: Information overload as the inverted U-curve (Source: Eppler & Mengis 2004)

Different approaches have been defined to determine when a party trying to locate specific information, is likely to experience information overload. The most general of these is by comparing the volume of information supply with the information processing capacity of an individual (Eppler & Mengis 2004). A more "classic" definition of information overload, based on the information-processing view of the organisation suggested by Galbraith (cited in Eppler & Mengis 2004) and expanded by Tushman and Nadler (cited in Eppler & Mengis 2004), is that information overload can be explained through the following formula:

$$\boldsymbol{information\ processing\ requirements} > \boldsymbol{information\ processing\ capacities}$$

The terms "requirements" and "capacities" in this definition can be measured in terms of available time (Eppler & Mengis 2004). In other studies (Iselin; Keller & Staelin; Owen; Scheider, all cited in Eppler & Mengis 2004), not only the amount of information and the available processing time (i.e., the quantitative

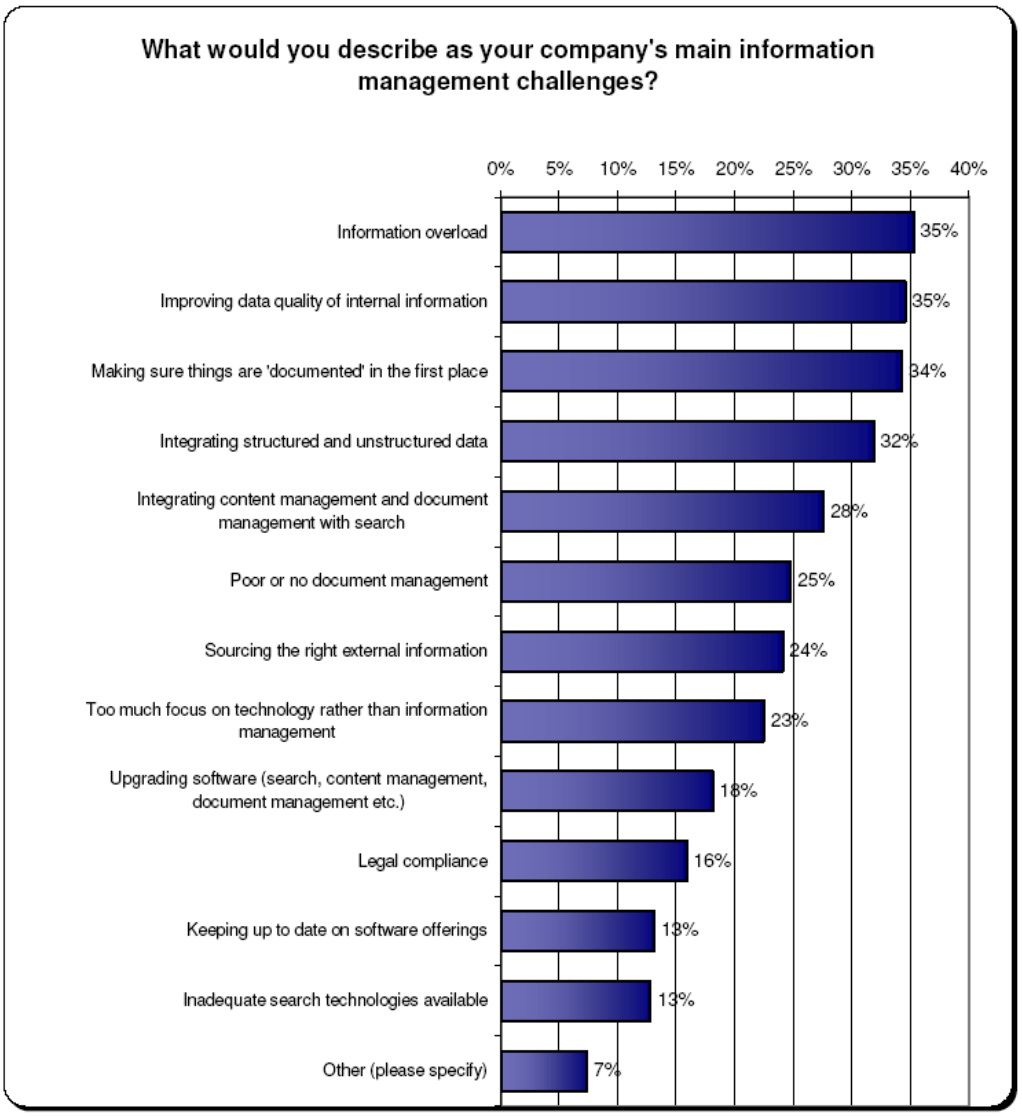


Figure 2.4: Survey results - Organisational information management challenges (Source: Information Management Independent Research Results 2006)

(Carlson 2003), which seems like a terrible waste of resources on something that only has a 20% chance of contributing to the organisation.

The issues of information management in organisations and the support of decision making in organisations will be discussed further in Chapter 3.

2.6 Causes of information overload

Carlson (2003) mentioned that 'technostress (i.e. information overload) results in reduced intellectual performance and poor judgment which, in a sort of negative feedback loop, partly causes, and is also partly

a result of, haphazard and random use of ICT' (Information and Communication Technologies), and that furthermore, the 'lack of a coherent conceptual knowledge management framework can also act as an aggravating factor.' The common perception is that ICT is the main cause (and the main driver) of the problem of information overload. The reality however, is that there are many disparate factors that can cause or contribute to the phenomenon of information overload.

In a review of literature from organisational science, accounting, marketing, MIS (management information systems) and other related disciplines on the problem and experience of information overload, Eppler and Mengis (2004) have grouped the causes of information overload into the following 5 main groupings: the *information* itself (with regards to quality, quantity, frequency, and intensity), the *person* receiving, processing or communicating information, the *tasks or processes* that needs to be completed by a person, team or the organisation, the *organisational design* (i.e. the formal or informal work structures), and the *information technology* used (and how it is used) in the organisation (see Figure 2.5).

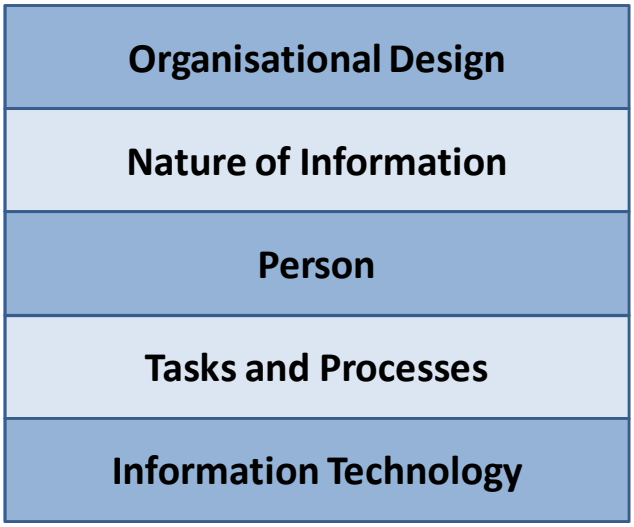


Figure 2.5: Causes of information overload

Of course, more often than not, it is not any single cause giving rise to information overload in a certain situation, but rather a combination of the five causes mentioned. Eppler and Mengis (2004) further note that all five of the causes for information overload influences the two fundamental variables of information overload, namely the information processing capacity (IPC) – which is (for example) influenced by personal characteristics – and the information processing requirements (IPR) – which are usually associated with the nature of the task or process to be performed (mentioned in section 2.4). The five main groupings of information overload causes will now be discussed in more detail:

- ***Organisational design***

Changes to the organisational design may result in existing information, communication, control and reporting structures not being capable to provide the information required to effectively manage the organisation in its new form, placing an increased IPR burden on the employees while the structures are being adapted. Disintermediation or centralisation (Schneider cited in Eppler & Mengis 2004), or because of a change to an interdisciplinary team approach (Bawden cited in Eppler & Mengis 2004) for instance, can lead to an increase in IPR as a need is created for more intensive communication and coordination. Conversely, effective coordination through the use of standards, common procedures, rules or dedicated coordination centres (Galbraith cited in Eppler & Mengis 2004) can reduce the IPR and positively influence the IPC of an organisation (Galbraith; Schick et al.; Tushman & Nadler; Schneider, all cited in Eppler & Mengis 2004).

- ***Nature of information***

It is not only the quantity of information that may cause information overload, but the characteristics of the information as well. These characteristics include the level of uncertainty associated with information and the level of ambiguity, novelty, complexity and intensity of the information (Schneider cited in Eppler & Mengis 2004). Ho & Tang (2001) presented a consolidated view on the nature of information, by stating that information overload can be influenced by the following dimensions of information (differing from the dimensions described by Hwang & Lin in section 2.4): the quantity of the information, the quality of the information, and the format (or diversity) of the information (see Figure 2.6).

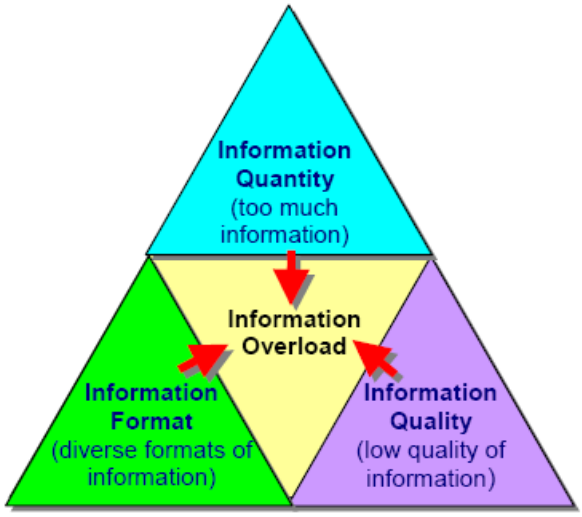


Figure 2.6: Dimensions of information overload (Source: Ho & Tang 2001)

- ***Information technology***

The development and deployment of new information and communication technologies, such as the Internet, intranets, and extranets, but especially e-mail, are universally seen as one major cause of information overload (Bawden cited in Eppler & Mengis 2004). As researchers have indicated that the lack of effective tools such as high quality search engines (Kehoe cited in Ho & Tang 2001) for information retrieval may contribute to the overload problem (Hiltz & Turoff cited in Ho & Tang 2001), different technologies and approaches have been developed in an attempt to manage the flow of information and provide users with the exact information they require – with varying success. At this stage searching and relevancy ranking algorithms still struggle to quickly provide a user with the information requested, and pushing technologies, in an attempt to provide the user with information that might be valuable, very easily end up flooding the user with unwanted information and causing a great deal of interruptions (Edmunds & Morris; Speier et al., all cited in Eppler & Mengis 2004). It can therefore be seen that, while ICT has drastically increased the individual's IPC, IPR has also increased at the same time (Eppler & Mengis 2004).

For a more detailed list of information overload causes, see Table 2.3.

Table 2.3: Causes for information overload (Source: Eppler & Mengis 2004)

Causes for Information Overload	
Personal factors	Limitations in the individual human information processing capacity
	Decision scope and resulting documentation needs
	Motivation, attitude, satisfaction
	Personal traits (experience, skills, ideology, age)
	Personal situation (time of the day, noise, temperature, amount of sleep)
	Senders screen outgoing information insufficiently
	Users of information adapt their way of interacting with computers too slowly with respect to the technological development
	Social communication barrier break down
Information characteristics	Number of items of information rises
	Uncertainty of information (info needed vs. information available)
	Diversity of information and number of alternatives increase
	Ambiguity of information
	Novelty of information
	Complexity of information
	Intensity of information
	Dimensions of information increase
	Information quality, value, half-life
	Overabundance of irrelevant information
Task and process parameters	Tasks are less routine
	Complexity of tasks and task interdependencies
	Time pressure
	Task interruptions for complex tasks
	Too many, too detailed for complex tasks
	Too many, too detailed standards (in accounting)
	Simultaneous input of information into the process

Causes for Information Overload	
	Innovations evolve rapidly – shortened life cycle
	Interdisciplinary work
Organisational design	Collaborative work
	Centralisation (bottlenecks) or disintermediation (information searching is done by end users rather than by information professionals
	Accumulation of information to demonstrate power
	Group heterogeneity
	New information and communication technologies (e.g. groupware)
Information technology	Push systems
	E-mails
	Intranet, extranet, Internet
	Rise in number of television channels
	Various distribution channels for the same content
	Vast storage capacity of the systems
	Low duplication costs
	Speed of access

Finally, an aspect which does not fit neatly into any of the five types of causes for information overload given by Eppler and Mengis, is the fact that the reasoning behind the information processing requirements might be the cause for information overload. In an organisational setting a manager might request for much more information than he/she actually needs for a task, for the wrong reasons. Butcher (cited in Edmunds & Morris 2000) provided a list of seven reasons why managers obtain so much information that they can easily be overwhelmed by it all:

- They collect information to indicate a commitment to rationalism and competence which they believe improves decision-making;
- They receive enormous amounts of unsolicited information;
- They seek more information to check out the information already acquired;
- They need to be able to demonstrate justification of decisions;
- They collect information just in case it may be useful;
- They play safe and get all information possible; and
- They like to use information as a currency – not to get left behind colleagues.

2.7 Symptoms of information overload

It is very clear that a heavy information load can have a negative effect on the performance of an individual (whether measured in terms of accuracy or speed). According to Eppler & Mengis (2004), when information supply exceeds an individual's information-processing capacity, a person has difficulties in identifying the relevant information (Jacoby cited in Eppler & Mengis 2004), becomes highly selective and

overload from occurring. Ho and Tang (2001) felt that an infomediary[3] approach could be utilised to mitigate the risk of information overload. They evaluated some known infomediary models in terms of the dimensions of information they have defined, namely information quantity, quality and format (see section 2.6, Nature of Information), the result of which is shown in Table 2.4[4]. The results clearly show that all these "agents" can control information quantity very well, but (as a group) are much less successful with ensuring information format and quality, giving a clear indication that the infomediary approach can unfortunately merely mitigate the effect of information overload, and not solve the problem completely.

Table 2.4: An infomediary approach to information overload solutions (Source: Ho & Tang 2001)

Infomediary Models	Information Quantity	Information Format	Information Quality
Portal	✓		
Virtual Community	✓		✓
Transaction Aggregator	✓		✓
Syndication	✓	✓	
Personalisation	✓		
Comparison	✓		✓

- ***Person***

On the individual level, *training programs to augment the information literacy of information consumers* (Bawden; Koniger & Janowitz; Schick et al., all cited in Eppler & Mengis 2004) was deemed very important, together with *providing employees with the right tools for improving their efficiency* (Bawden cited in Eppler & Mengis 2004) and *information management skills* (Edmunds & Morris cited in Eppler & Mengis 2004).

[3] *'Consumers won't have the time, the patience, or the ability to work out the best deals with information buyers on their own. In order for consumers to strike the best bargain with vendors, they'll need a trusted third party - a kind of personal agent, information intermediary, or infomediary - to aggregate their information with that of other consumers and to use the combined market power to negotiate with vendors on their behalf.' (Hagel cited in Ho & Tang 2001)*

[4] *Brief descriptions of the indicated infomediary models are as follows: Portal - a web site that provides broad services including searching, yellow pages, and link to other sites; Virtual Community - a group of individuals that share common interest and ideas among community members through e-mail, chatting, or newsgroups. Transaction aggregators create electronic market places to enable critical mass of vendors and customers to connect with each other and conduct transactions based on the rules and procedures. Syndication - a form of infomediary that collects and packages digital information, aggregating content from many sources. Personalisation - the concept of deciding – given a large set of possible choices – which piece of information has the highest value to an individual. Comparison sites, such as Gomez.com (http://www.gomez.com), or Bizrate.com (http://www.bizrate.com), allow users to search for a product by name, category (e.g. computers, insurance, or travel) or a number of specific parameters (e.g. price, speed, or service quality) (Ho & Tang 2001).*

- ***Tasks and processes***

For information overload experienced as a result of process problems, the following have been proposed as possible remedies: *standardisation of operating procedures* (Bawden; Schick et al.; Schneider, all cited in Eppler & Mengis 2004), *collaboration with information specialists* within the process teams (Edmunds & Morris cited in Eppler & Mengis 2004), and *the use of facilitators or collaborative tools (such as virtual team rooms) as "process enablers" for cognitive support* (Grise & Gallupe cited in Eppler & Mengis 2004).

- ***Information technology***

Finally, when looking at the impact that information technology can have on addressing information overload, *the use of intelligent information management systems for fostering an easier prioritisation of information* (Bawden; Meyer; Schick et al., all cited in Eppler & Mengis 2004) and *the providing of quality filters* (Ackoff; Edmunds & Morris; Grise & Gallupe, all cited in Eppler & Mengis 2004) are some of the main solutions advocated. Examples of such intelligent systems are *decision support systems* (DSS) aimed at portraying large quantities of information in a manageable manner and size (Cook cited in Eppler & Mengis 2004). Advocating a less-traditional solution to the problem of information overload, Belfourd and Furner (cited in Edmunds & Morris 2000) feels that intelligent agents should be used because of the fact that an intelligent agent acts autonomously by making decisions on the basis of data it acquires about the environment, rather than as a result of direct instruction from the user, as well as the fact that an intelligent agent has the facility to learn about the personal preferences of an individual so that it is able to gradually predict the likelihood of items that will be of interest to the user (see also Paes (1994)).

A more detailed list of countermeasures against information overload compiled by Eppler and Mengis (2004) is provided in Table 2.5.

Table 2.5: Countermeasures against information overload (Source: Eppler & Mengis 2004)

Countermeasures against Information Overload	
Personal factors	Improve personal time management skills and techniques
	Training programs to augment information literacy: information-processing skills such as file handling, using e-mail, classification of documents, etc.
	Improve personal information management
	Systematic priority setting
	Improve the screening skills for information
Information characteristics	Raise general quality of information (i.e. its usefulness, conciseness) by defining quality standards
	Focus on creating value-added information
	Promulgation of rules for information and communication design (e.g. e-mail etiquette)

Countermeasures against Information Overload	
	Compress, aggregate, categorize and structure information
	Visualisation, the use of graphs
	Formalisation of language
	Brand names for information
	Form must follow function must follow usability
	Simplify functionalities and design of products
	Customisation of information
	Intelligent interfaces
	Determine various versions of an information with various levels of detail and elaborate additional information that serves as summaries
	Organise text with hypertext structures or gophers
	Interlink various information types (as internal with external information)
Task and process parameters	Standardise operating procedures
	Define decision models developed for specific decision processes (e.g. decision rules)
	Install an exception-reporting system
	Allow more time for task performance
	Schedule interrupted blocks of time for completing critical work
	Adequate selection of media for the task
	Handle incoming information at once
	Collaboration with information specialists within the teams
	Bring decisions to where information exists when this information is qualitative and ambiguous
	Install process enablers for cognitive support
	Use simpler information-processing strategies
	Regulate the rate of information flow
	Search procedures and strategy
	Define specific, clear goals for the information in order to contextualize it and turn it meaningful
	Communicate information needs to providers
	Provide incentives that are directly related with decisions in order to make decision relevant information be processed more efficiently
	Install a measurement system for information quality
Organisational design	Coordination through interlinked units
	Augment info processing capacity through changes in org. design
	Creation of lateral relationships (integrate roles, create liaisons between roles, teamwork etc.)
	Coordination by goal setting, hierarchy and rules depending on frequency of exceptions (uncertainty)
	Creation of self-contained tasks (reduced division of labour, authority structures based on output categories) → autonomous groups
	Reduce divergence among people (e.g. with regard to expectations) through socialisation (e.g. frequent face-to-face interactions)
	Install appropriate measures of performance
	Hire additional employees
	Create slack resources
Information technology application	Intelligent information management (prioritisation)
	Install voting structures to make users evaluate the information
	Prefer push to pull technologies
	Facilitator support through (e-)tools
	Decision support systems should reduce a large set of alternatives to manageable size

Countermeasures against Information Overload	
	Use natural language processing systems (search with artificial intelligence)
	Information quality filters
	Intelligent data selectors (intelligent agents)
	Use systems that offer various information organisation options (e.g. filing systems)

2.9 Conclusion – Information overload

People's innate ability to generate and share information has led to massive amounts of information that is increasing continuously, and lacks consistency in terms of quality. Workers having to assess information are overwhelmed by the sheer volume and diversity of this information, and it is therefore quite clear that they require assistance in performing their work efficiently.

Different causes for the occurrence of information overload have been identified in this chapter as being the person him/herself, the characteristics of information, the parameters of tasks and processes to be completed, organisational design and the application of information technology. The rest of this thesis will focus solely on addressing the problem of information overload in terms of information technology and the nature of information itself, and any reference to information overload from this point on will signify only that.

This aim of this thesis is to discuss a way to solve the problem of information overload for knowledge workers and decision makers in an organisation, or at least to cushion aforementioned persons against the full impact of information overload through an implementation of a combination of the following solutions (mentioned in the previous section):

- Delivering the information in the most convenient way and format;
- Visualisation, compression and aggregation of the information;
- Using methods of intelligent information management for easier information prioritisation; and
- Using quality filters.

The next chapter will explain the manner in which information is used within an organisation, which has a direct influence on its decision making ability.

Chapter 3 – Organisations and Information

3.1 Introduction

> 'Information is not merely a necessary adjunct to personal, social and organisational functioning, a body of facts and knowledge to be applied to the solution of problems or to support actions. Rather it is a central and defining characteristic of all life forms, manifested in genetic transfer, in stimulus response mechanisms, in the communication of signals and messages and, in the case of humans, in the intelligent acquisition of understanding and wisdom' (Kaye, cited in Rowley & Farrow 2000).

More and more humanity have started to realise the importance of information for its continued survival and success. Some of the more significant ways in which information is employed by humans are the following (Rowley & Farrow 2000):

- Decision-making;
- Problem-solving;
- Communication and interpersonal relationships;
- Learning;
- Entertainment & leisure;
- Citizenship; and
- Business & professional effectiveness.

> 'Without an uninterrupted flow of the vital resource, society as we know it would quickly run into difficulties, with business and industry, education, leisure, travel, and communications, national and international affairs all vulnerable to disruption. In more advanced societies this vulnerability is heightened by an increasing dependence on the enabling powers of information and communications technologies' (Martin, cited in Rowley & Farrow 2000).

Information has been an integral part in the world of business from the beginning, assisting decision makers in determining the exact specifications of a product or service to be provided to a customer, how to ensure that the value offering of the organisation is superior to that of the competition, and how to deliver it in the most effective and efficient manner. Internal to the organisation, information is more than a

developed on the current and future conditions of its environment (Choo 2000), such an *intelligent organisation* will start to develop the ability to better deal with complexity and be able to better react on signals from its environment (Haeckel & Nolan, cited in Choo 2000).

It is very obvious that information is indispensable, and that it can have a significant impact on the success of organisations. The potential severe consequences of the loss or inability to find specific information are driving organisations to seek better and more versatile methods and systems to efficiently extract information from the environment, and structure it to maximise its value to the organisation (Choo 2000). The extraction of information from the environment do however also carry the risk of inducing information overload (discussed in Chapter 2) within an organisation, which is why the manner in which an organisation uses and interacts with the information should be very carefully defined, as the incorrect utilisation and interaction with information can very easily have an adverse effect on organisational efficiency and productivity (Choo 2000). This chapter will consider some of the ways in which organisations currently utilise information, the shortcomings of the more commonly used approaches that are employed in organisations, and some improvements that were developed based on these shortcomings, which has improved the extent to which organisations utilise information (see Figure 3.1).

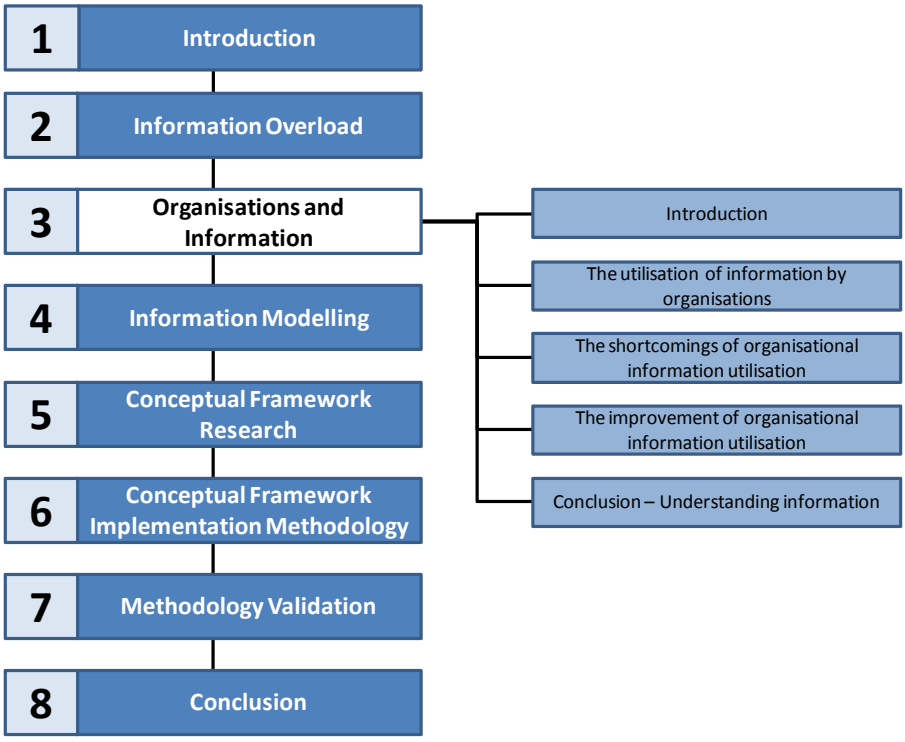


Figure 3.1: Image for navigating thesis and chapter 3

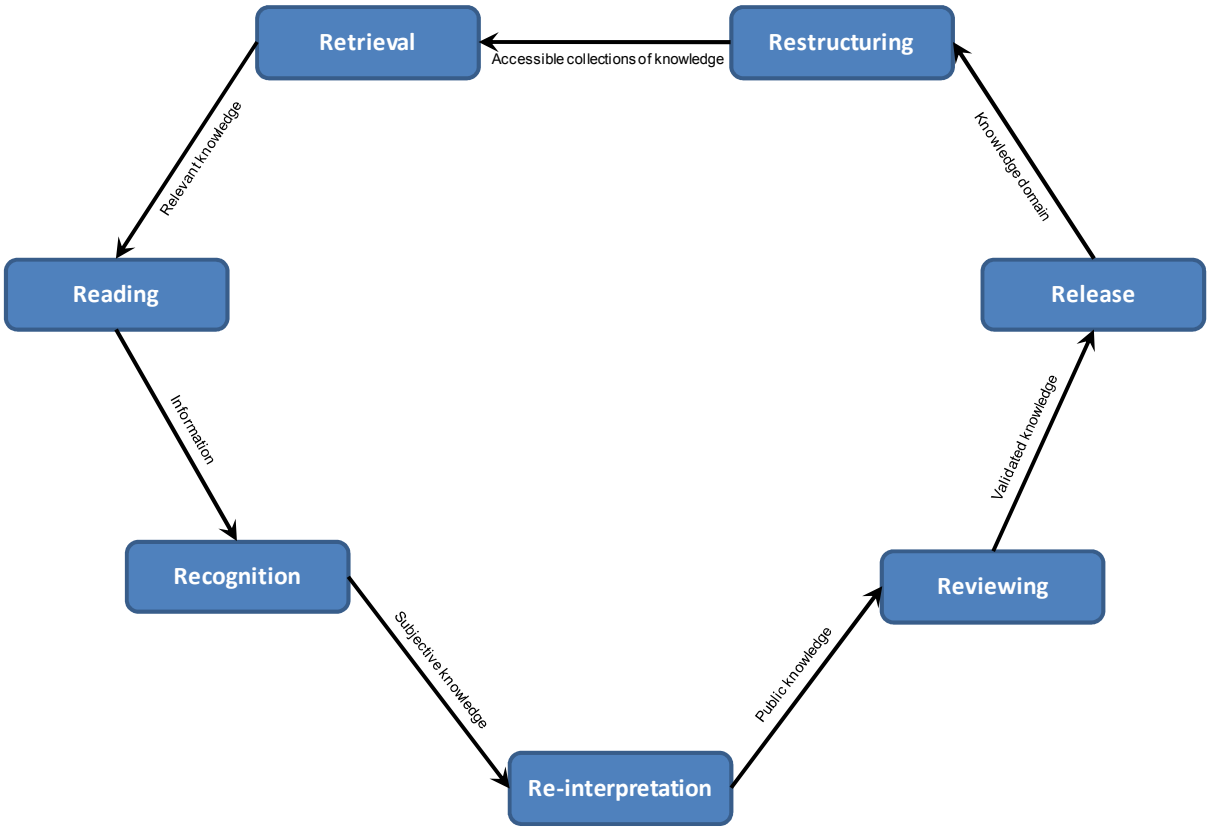


Figure 3.2: The 7 R's of Information Management (Source: Rowley & Farrow 2000)

2. 'Once read, the *Relevant knowledge* becomes *Information* which is absorbed into the cognitive framework of the individual.' 'This process of Recognition is concerned with matching the concepts in the user's cognitive framework with those in the document that is read. Recognising is concerned with converting information into *Subjective knowledge*.'

3. 'Re-interpretation is concerned with the conversion of knowledge into a form than can be easily communicated, such as in a document.' 'We describe this information as *Public knowledge*.'

4. 'Reviewing or evaluation is concerned with the conversion of public knowledge into *Validated knowledge*.'

5. 'Release or distribution is concerned with making public knowledge available within the community, organisation or market-place that might find it to be of value.' 'Once validated knowledge has been released, it enters the *Knowledge domain* upon which individuals, organisations and communities can draw.'

6. 'Organisations will interact with this knowledge domain, select items from it and collect or provide routes of access to a subject in the knowledge domain that they judge to be of specific interest in meeting their objectives.' Various processes can be executed in the 'Restructuring of knowledge to meet a specific purpose. This *Collection of knowledge* will be supplemented within organisations by

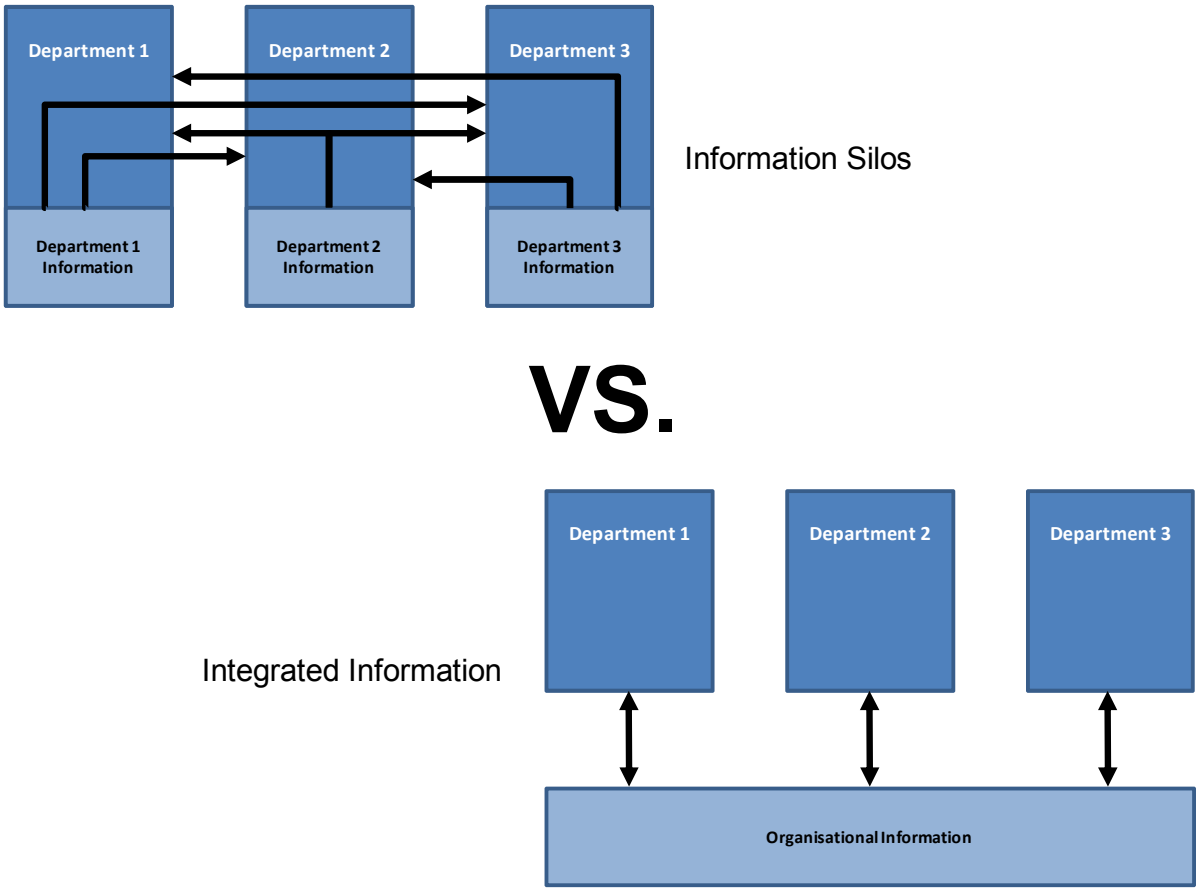


Figure 3.3: The difference in complexity between interaction with information in an information silo environment, and interaction with information in an integrated information environment

- ***Shared directories (Documents)***

Having shared directories for document storage is possibly one of the simplest and most effortless approaches for interaction with information that exists. It basically entails the creation of directories or folders (terminology used by Microsoft, Apple, and some other software development corporations) at an agreed-upon location on a computer network, and giving specific users access to use it for the storage and retrieval of electronic documentation (and therefore, information). In a highly context-specific environment this approach should work very well, as only a limited number of documents will be stored in the shared directories, and because the context is known to the users, the retrieval of information should take place without any difficulty. It is, however, not advisable to use shared directories for major information storage, as the storage of documents are done very subjectively, and very little or no assistance is usually provided for the locating and retrieval of information.

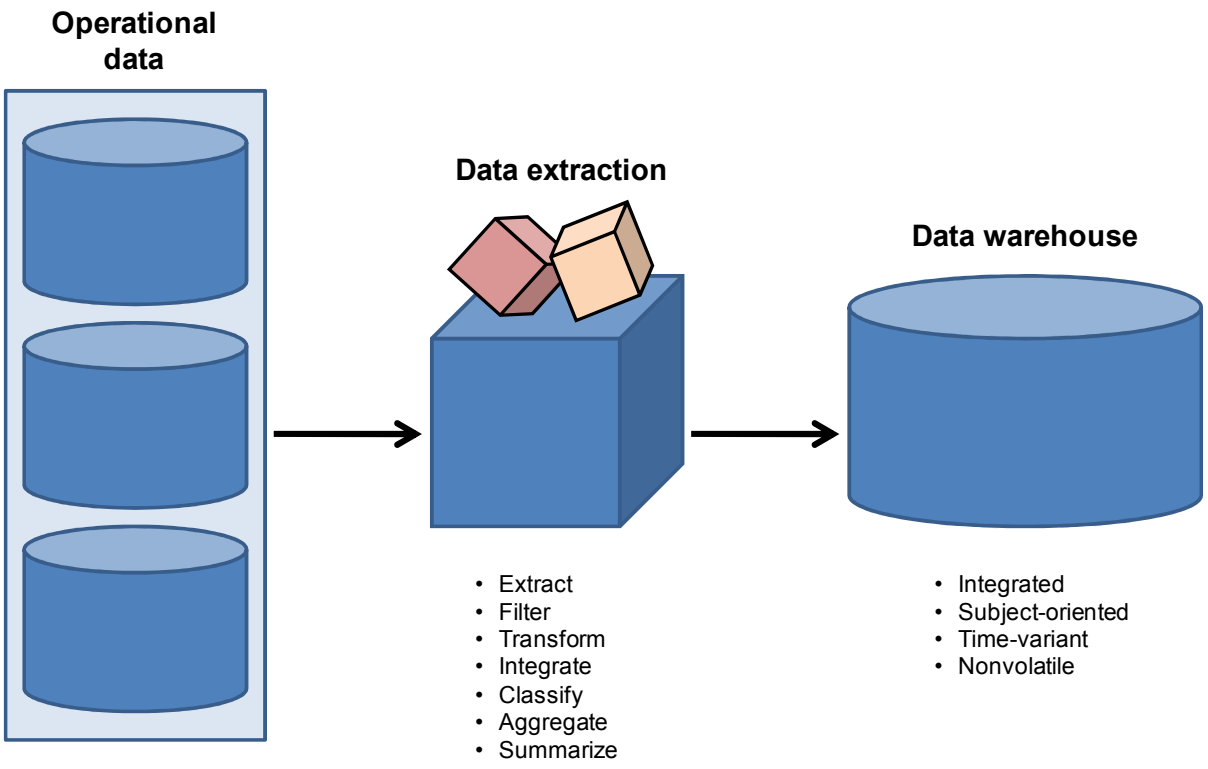


Figure 3.4: Creating a data warehouse (Source: Rob & Coronel 2000)

- ***Data marts and operational data stores (Transactions)***

A data mart is a specialised type of data warehouse that contains only a subset of corporate data that is of value to a specific department or set of users (Pipe 1997). In scope, the information it contains can be derived from an enterprise-wide database (like a data warehouse) or be more specialised (SearchOracle.com 2005) by, for instance only focusing on specific operational systems. Data marts focus on meeting the specific demands of a particular group of users in the organisation, in terms of analysis, content, presentation, and ease-of-use, and therefore users of a data mart can expect to have data presented in terms that are familiar (SearchOracle.com 2005). The smaller size of data marts makes it faster and less expensive to build than data warehouses, but this means that the capability to perform analyses on organisation data across functional area boundaries is severely inhibited (Pipe 1997).

Another specialised application of the data warehouse concept is the *operational data store*. As with data warehouses, information is also captured and integrated from the different operational systems and external information providers of the organisation, but operational data stores focus more on providing knowledge workers with current (or near-current) detailed data for regular day-to-day business querying and reporting (Pipe 1997). Its aim to provide better information for fast decision making, means thus that it contains very little or no summarised or historical data.

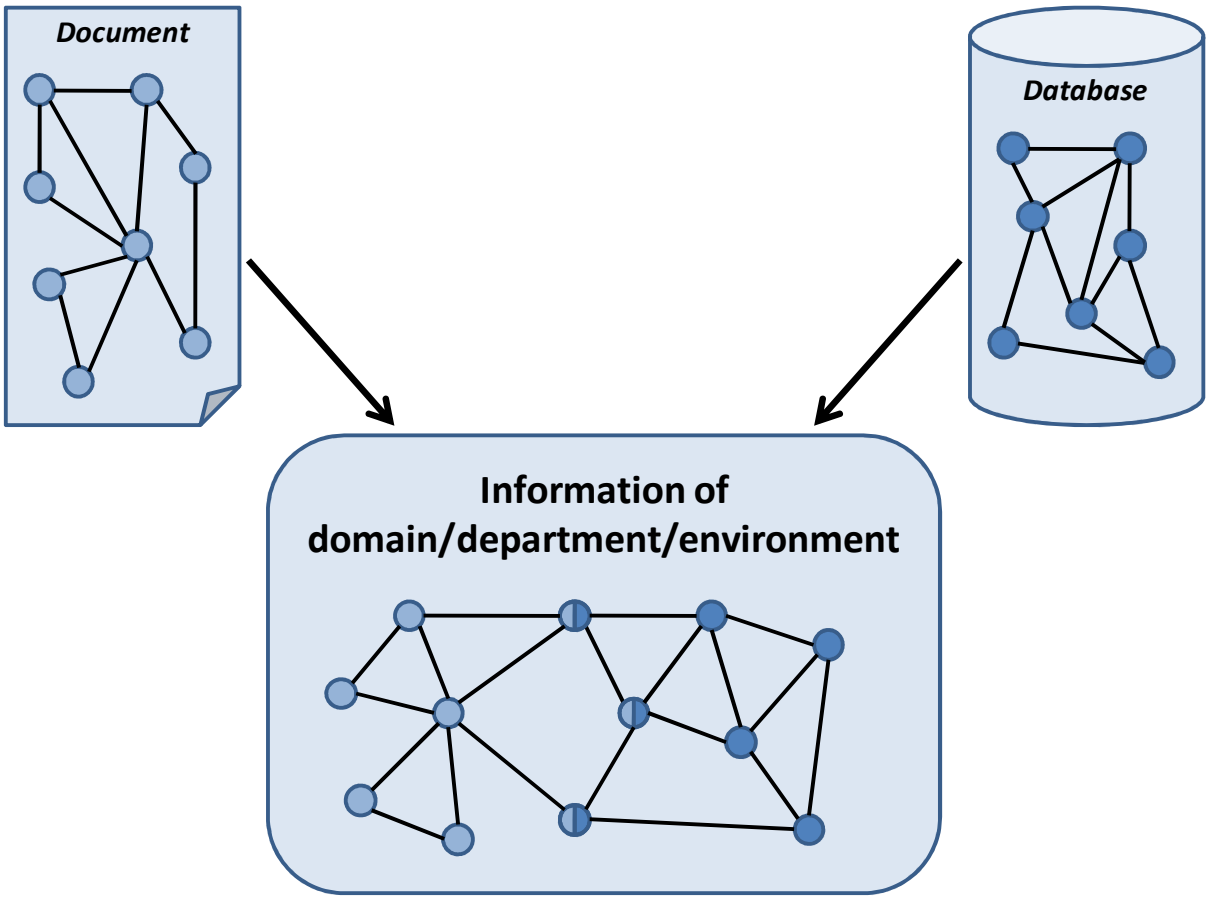


Figure 3.5: Information represented as networks of data points and the relations that exist between them, as well as the single network that results from combining the various individual networks

The idea of modelling the data points (or entities) of an organisation and the relations between them, have already existed for some time. Already in 1976, Chen (1976) have defined the entity-relationship model as a proposed means of conceptually modelling all of an organisation's information, which also provided a basis for integrated information in the organisation (Goodhue, Wybo & Kirsch). It is however currently used more by database and systems developers in the design of organisational information systems.

It can naturally be asked whether normal information users in the organisation can also benefit from having an entity-relational view on information, and navigating these networks (possibly even through visual browsing (Conway & Sligar 2002)) to acquire certain information. This will be further discussed in the following chapters.

structuring of information, and therefore, for the remainder of this chapter, the focus will be shifted to this aspect of information modelling. This chapter focuses on discussing a number of existing information structuring approaches (see Figure 4.1) which were designed to improve the interaction and utilisation of information, and which are currently employed in a large variety of different environments and contexts.

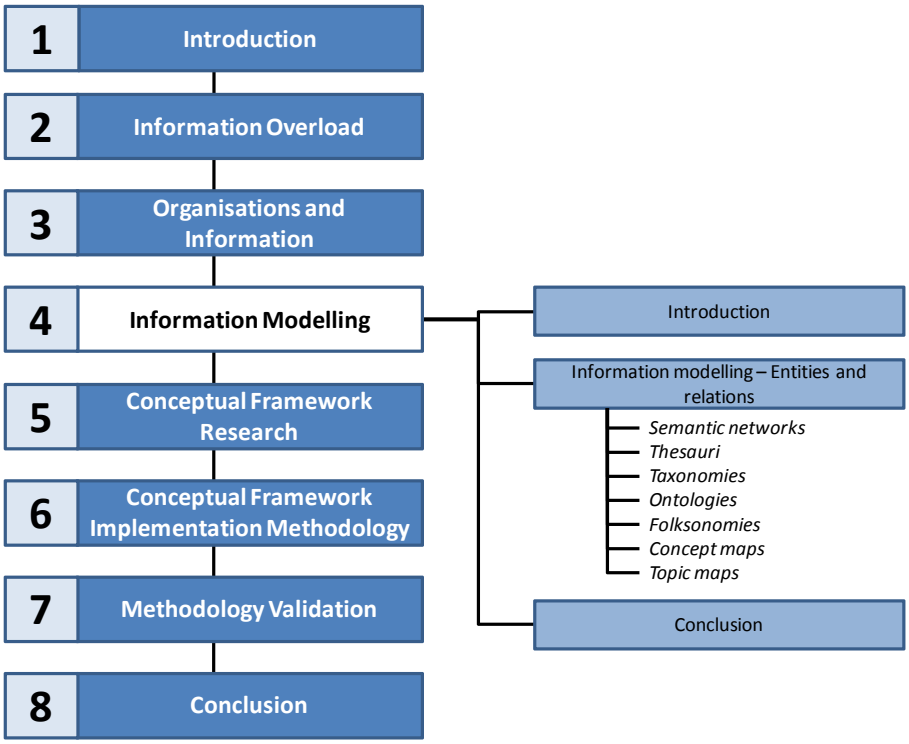


Figure 4.1: Image for navigating thesis and chapter 4

4.2 *Information modelling - Entities and relations*

The concept of representing information in terms of entities and relations is definitely not new. The entity-relationship model was defined already in 1976 by Peter Chen of the Massachusetts Institute of Technology, from which he derived the entity-relationship diagram (ERD), a technique which is very well known to database designers especially, but probably also to most other types of information systems designers and engineers (as an example, see Figure 4.2). The model was specified to be used as a 'basis for a unified view of data' (Chen 1976), and combined the main features and advantages of three other major data models of the time: the network model (Bachman; Bachman; CODASYL, all cited in Chen 1976), the relational model (Codd, cited in Chen 1976) and the entity set model (Senko et.al., cited in Chen 1976). Chen specified that, in the study of a data model, the levels of logical views of data with which the model is concerned should be identified. Four levels of data views were defined:

1. 'Information concerning entities and relationships which exist in our minds.

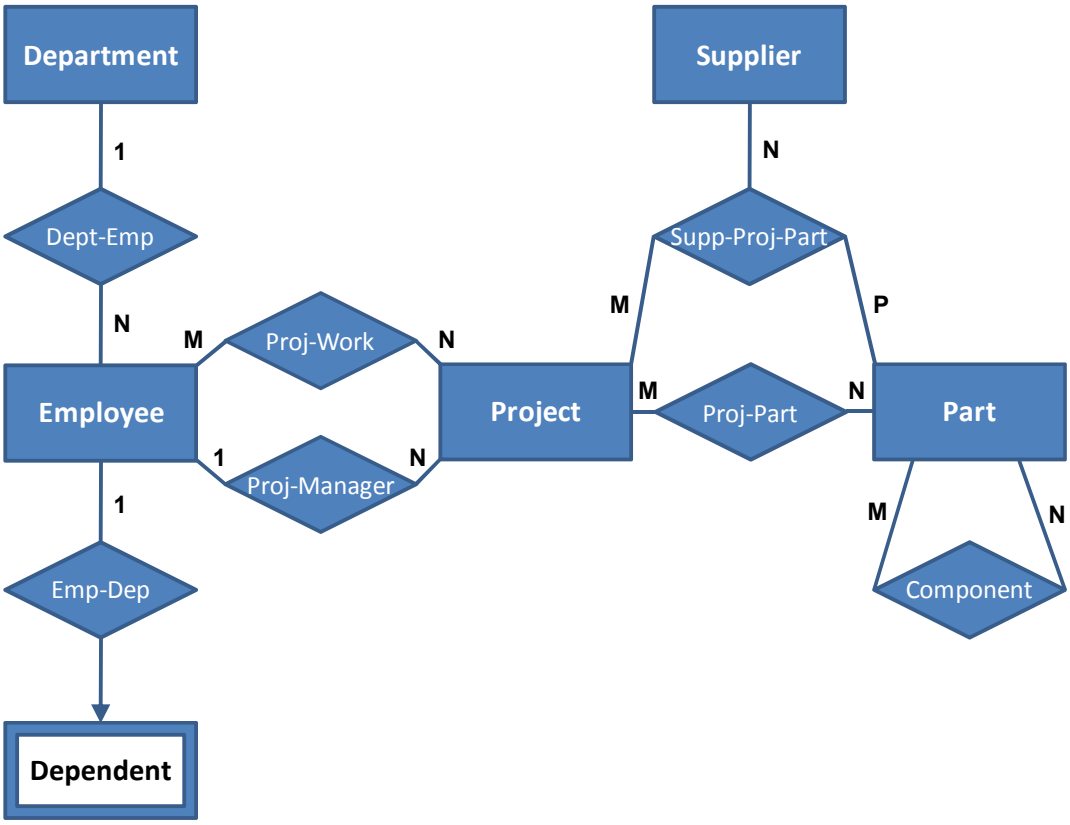


Figure 4.2: An example of an entity-relationship diagram for analysis of information in a manufacturing firm (Source: Chen 1976)

2. Information structure – organisation of information in which entities and relationships are represented by data.
3. Access-path-independent data structure – the data structures which are not involved with search schemes, indexing schemes, etc.
4. Access-path-dependent data structure.' (Chen 1976)

It can be seen that in level 1, Chen proposed the use of entities and relationships as the basis for information modelling, which he defined very concisely as follows:

'An *entity* is a "thing" which can be distinctly identified. A specific person, company, or event is an example of an entity. A *relationship* is an association among entities. For instance, "father-son" is a relationship between two "person" entities.'

These definitions are indeed very rudimentary, but through this understanding of information, Chen managed to define an accepted approach through which the manner in which information exists in peoples' minds could be modelled, so that a common understanding of information could be reached. Not too long after that, in 1982, William McCarthy also defined the REA Accounting Model (so named after its primary components which consist of sets representing economic *r*esources, economic *e*vents and

Examples of the manner in which these relations are employed are shown below (from the Thesaurus of Engineering and Scientific Terms) (Cann 1997):

- Excavating machinery

  Use Excavating equipment

- Evaporative cooling

  BT Cooling

  NT Film cooling

  RT Cooling systems

  Cooling towers

- Fixed investment

  UF Capital investment

More examples of thesauri can be seen in Figure 4.5 and Table 4.1 where two internet thesauri were queried for the term “intelligent”. Both examples provide related terms, synonyms and antonyms of “intelligent” The example from Free Dictionary (2007) furthermore also provides different meanings of the term “intelligent”.

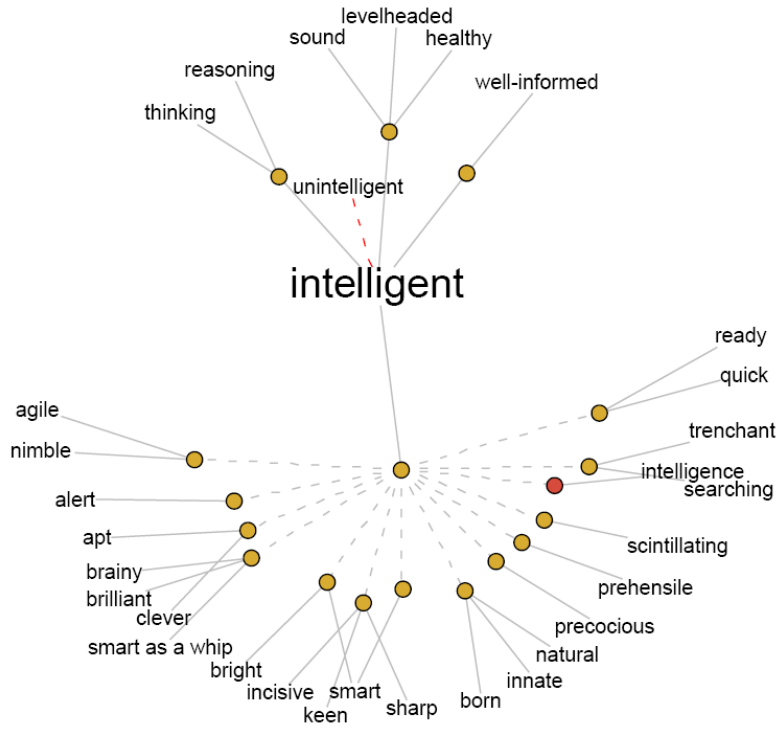


Figure 4.5: Another example of Internet thesaurus result for the term "intelligent" (Source: Thinkmap Visual Thesaurus 2007)

Table 4.1: Example of Internet thesaurus result for the term "intelligent" (Source: Free Dictionary 2007)

Adj.	**1.**	**intelligent** - having the capacity for thought and reason especially to a high degree; "is there intelligent life in the universe?"; "an intelligent question"	
		Related Word	smart - showing mental alertness and calculation and resourcefulness
		Related Word	precocious - characterised by or characteristic of exceptionally early development or maturity (especially in mental aptitude); "a precocious child"; "a precocious achievement"
		Antonym	unintelligent, stupid - lacking intelligence; "a dull job with lazy and unintelligent co-workers"
	2.	**intelligent** - possessing sound knowledge; "well-informed readers"	
		Synonym	well-informed
		Related Word	sophisticated - having or appealing to those having worldly knowledge and refinement and savoir-faire; "sophisticated young socialites"; "a sophisticated audience"; "a sophisticated lifestyle"; "a sophisticated book"
	3.	**intelligent** - exercising or showing good judgment; "healthy scepticism"; "a healthy fear of rattlesnakes"; "the healthy attitude of French laws"; "healthy relations between labour and management"; "an intelligent solution"; "a sound approach to the problem"; "sound advice"; "no sound explanation for his decision"	
		Synonym	level-headed, levelheaded, sound, healthy
		Related Word	reasonable, sensible - showing reason or sound judgment; "a sensible choice"; "a sensible person"
	4.	**intelligent** - endowed with the capacity to reason	
		Synonym	reasoning, thinking
		Related Word	rational - consistent with or based on or using reason; "rational behaviour"; "a process of rational inference"; "rational thought"

- ***Application***

Peter Roget produced the first thesaurus in 1852, which was the *Thesaurus of English Words and Phrases*. Roget referred to the thesaurus as being a “verbal classification” (Gilchrist 2003) in which entries were arranged to facilitate the expression of ideas and to assist in literary composition (Oakes n.d.). This function of a thesaurus is still mostly attributed to it today.

When considering the application of thesauri in the structuring of information however, instead of helping to produce diversity of vocabulary in text, it is tasked to the standardising of vocabulary, which in turn expedites the retrieval of information. Foskett (cited in Oakes n.d.), listed the main uses of thesauri for information retrieval as follows:

- Thesauri provide a map of a given field of knowledge, showing concepts and relations.
- Thesauri provide a standard vocabulary for consistent indexing.
- Thesauri assist users with locating terms for proper query formulation. (An example of a query would be the words chosen as input to a web search engine).

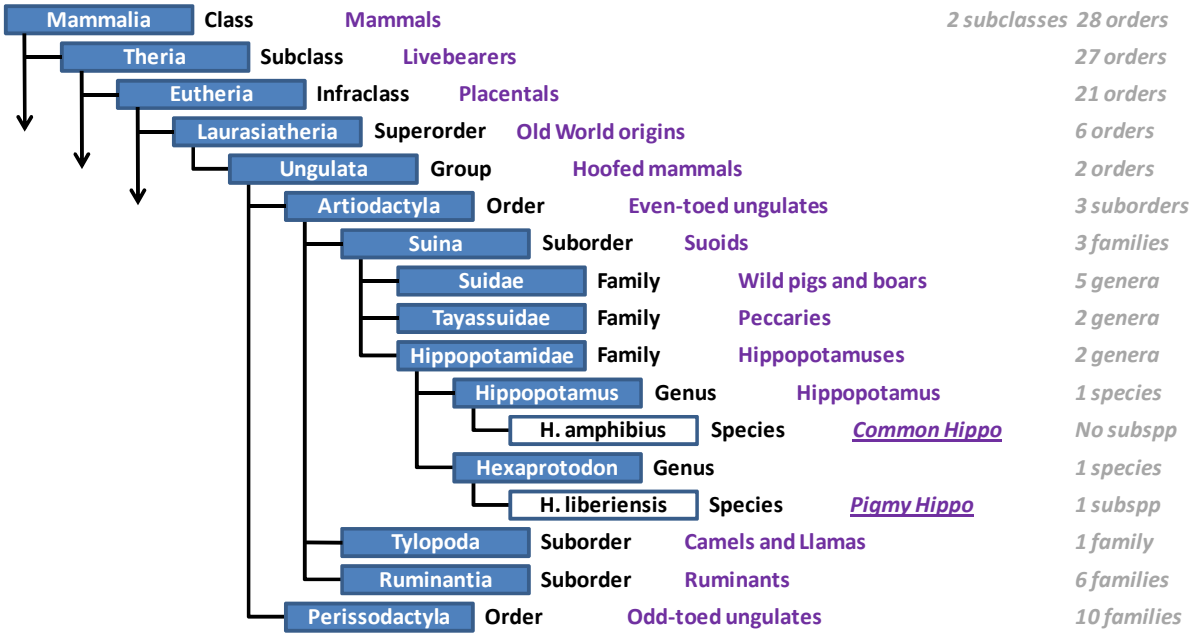


Figure 4.6: An example of a taxonomy - Taxonomy of the hippopotamus (Source: Hippopotamus Taxonomy n.d.)

This however does not mean that the taxonomy approach is exclusive to the biological domain. The most widely used taxonomy in the world, the Dewey Decimal System, is well known in library science (Wyllie, cited in Cheung, Lee & Wang 2005), and according to Mertins, Heisig and Vorbeck (2005), increased use of taxonomies have also been noted in the more abstract branches of economics and science. Gilchrist (2003) have however noted that, through differences in the understanding of what a taxonomy is, a large number of techniques and applications were being implemented in large organisations as taxonomies. From a number of case studies, he found the five most common impressions of what taxonomies are to be, as follows:

1. Web directories: Web directories are commonly used on the Internet, and are increasingly being utilised in intranets. A menu of top terms is presented to the user. Clicking on a term will display a second level, and so on for several more levels, until the user finally arrives at a reference or a link concerning the sought-after information. Web directories are definitely a form of classification, but each level does not have to be hierarchical in the accepted sense. Terms may therefore be repeated at different levels (contrary to the requirements of a taxonomy), providing alternative pathways for the searcher.

2. Taxonomies to support automatic indexing: In this case, a classification of terms exists, with an algorithm associated with each term, comprising sets of words and phrases, synonyms and syntactic variations, weights and instructions. These algorithms then act as a rules base which is used for the automatic extraction of appropriate indexing terms from documents where manual indexing would not be economically viable. These structures can however rather be considered as enriched thesauruses than as actual taxonomies.

(Chandrasekaran, Josephson, & Benjamins, cited in Edgington et al. 2004), making provision for axioms and constraints to be added on top of the hierarchy of concepts and subsumption relations, thereby fully binding the intended interpretation of the ontology. Within the information systems environment, ontologies are therefore not only suitable for describing or modelling the information system, but are also very well suited for interacting with it.

For better understanding of the possibilities offered by ontologies, one should have a good understanding of the function of its components. Ontologies are usually composed of concepts (also known as classes), relations, constraints, axioms, and attributes (also known as roles or properties) (see Figure 4.7):

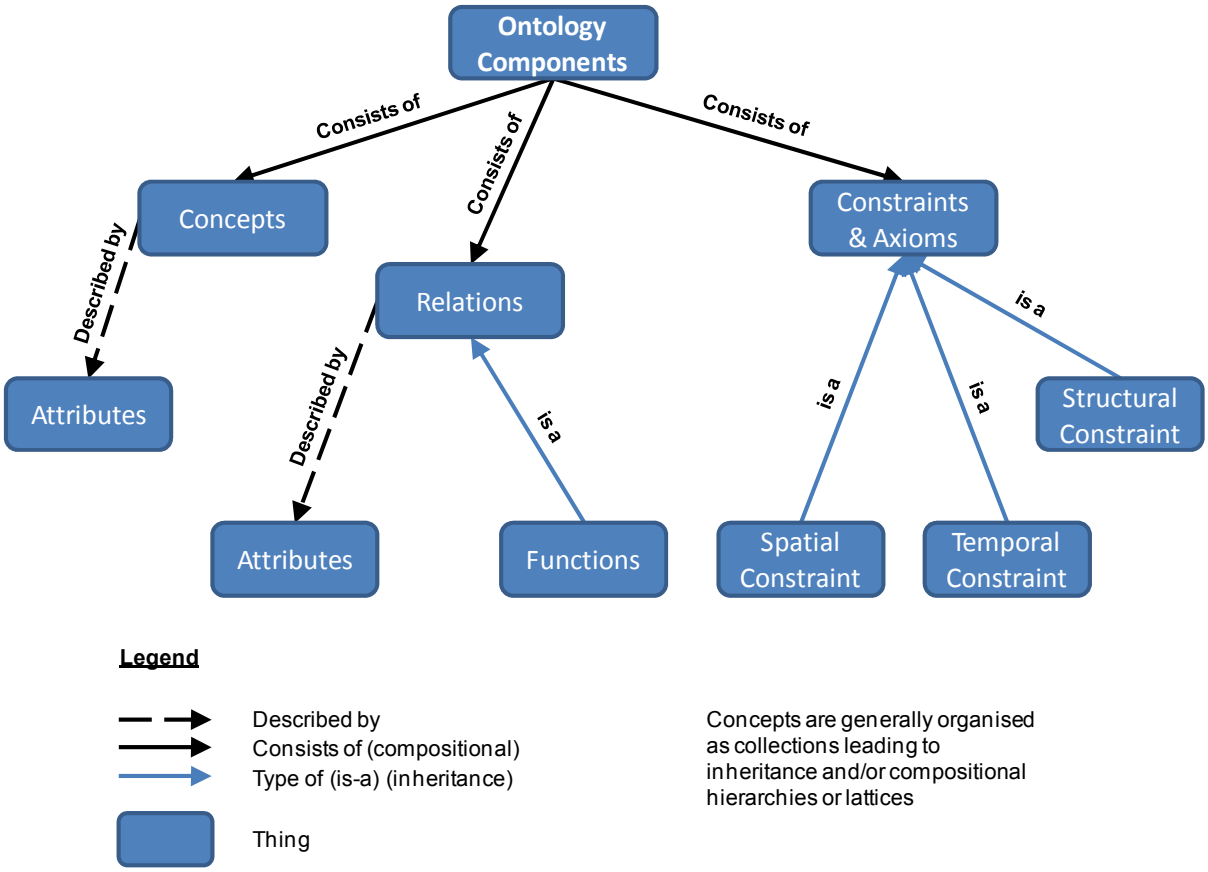


Figure 4.7: The components of an ontology (Source: Kishore, Sharman & Ramesh 2004b)

- Concepts: A concept can be defined as an abstract or general idea inferred or derived from specific instances. Within the information systems environment, these concepts denote terms and other aspects of the domain that are relevant to those who interact with it, and can usually be categorised as being either elementary or composite (Kishore, Sharman & Ramesh 2004b). These concepts are furthermore only labels or identifiers for real "things" found in the domain, with these "things" indicated as instances of the concepts within the ontology. Concepts can be grouped together into categories (Kishore, Sharman & Ramesh

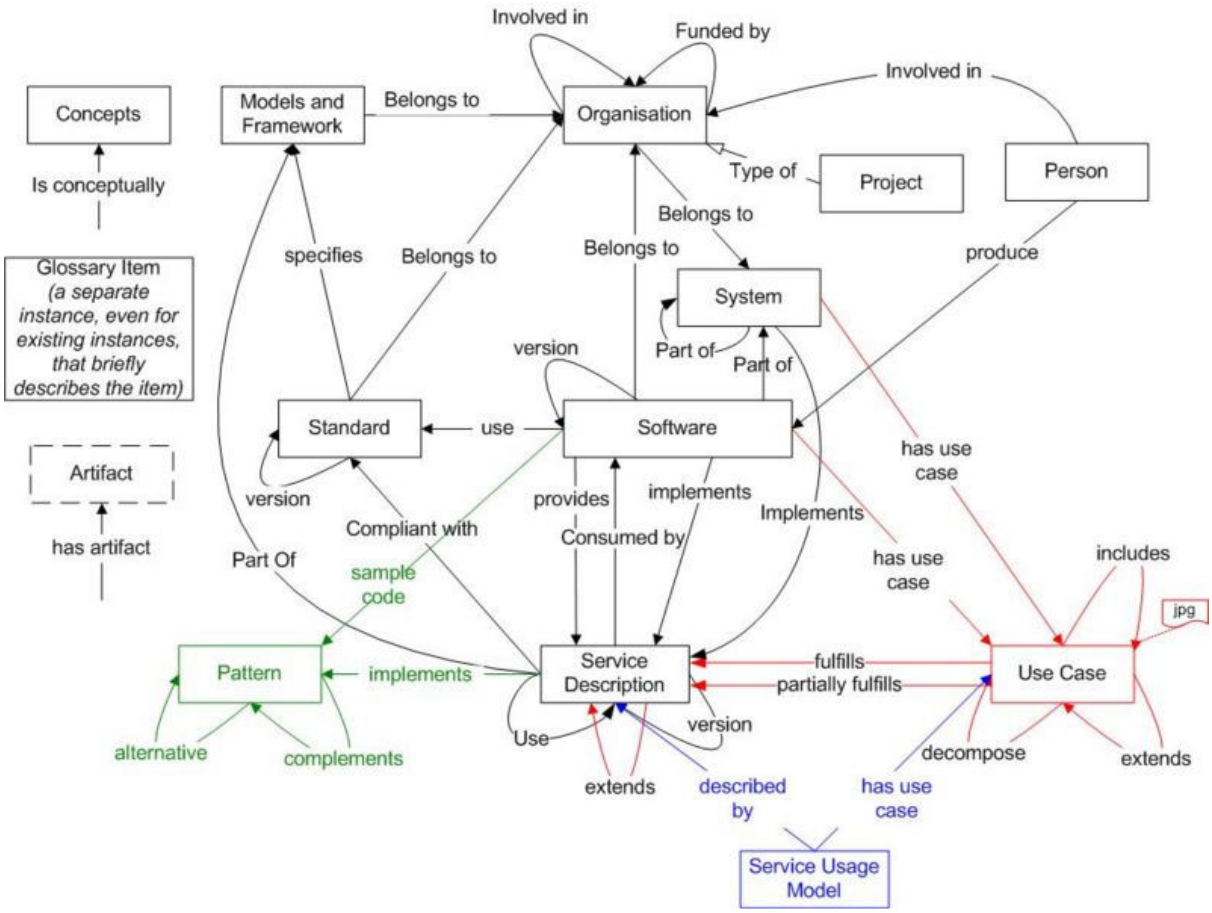


Figure 4.8: An example of an ontology (Source: FREMA Ontology 2006)

- To create a shared understanding of the structure of information among people or software agents;
- To enable the reuse of information in the knowledge domain;
- To make the assumptions underlying the knowledge domain explicit and well-understood;
- To specify the knowledge embodied in an ontology at an appropriate level of granularity (universe, bounded universe, domain, operational); and
- To provide means for analysing domain knowledge.

For a more clearly defined categorisation of ontology types, the research of Jasper and Uschold (cited in Kishore, Sharman & Ramesh 2004a) identifies the following four broad groups of ontologies (based on their manner of application):

- Ontologies for knowledge reuse;
- Ontologies as specification;
- Ontologies as a provider of common access of heterogeneous information; and

happening is quite unlike classification and far more like categorisation'[10]. From these different views, it is quite obvious that the concept still requires quite some discussion and research for it to reach maturity, but to get a better understanding of the concept without getting bogged down in semantics, it would be prudent to take a step back and first consider the activity from which a folksonomy originates, namely tagging.

Tagging can be seen as a type of collaborative free keyword indexing, where there are no indexing rules and users can tag content with any words they see fit (Stock 2007). Rather than adhering to a fixed information categorisation structure, these tags are attached to information in a random manner, aimed purely at providing a specific user with the means to retrieve information of a personal interest at a later time. What makes the use of tags so appealing to users, is that, instead of being forced to describe a piece of information by using the author's vocabulary or the vocabulary of a particular classification or categorisation system, users can apply their own language and vocabulary with which to describe the information (Mathes 2004). Tags can be words, acronyms, numbers or anything else that will assist the user in retrieving information, and the user is free to use the tags in any way that he/she feels appropriate, without having to agree with other users about how the specific content should be tagged (Shirky 2005) (see Figure 4.9).

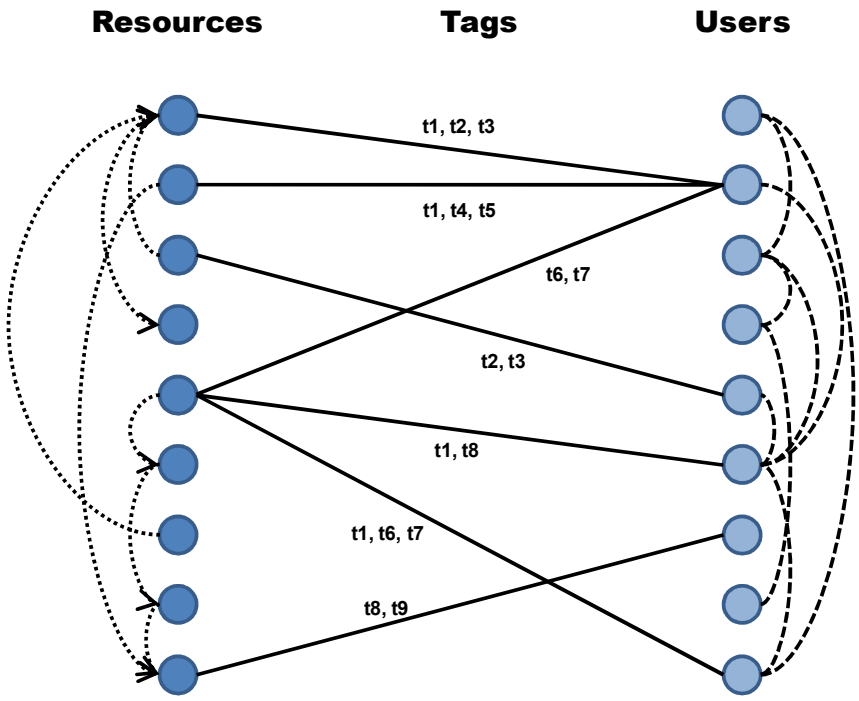


Figure 4.9: A model of a tagging system (Source: Auray 2007)

Through the tagging of various pieces of information content, related information are also grouped together, which happens purely because of the tagging itself and not through the use of fixed

[10] *To maintain coherence, "folksonomy" will be used for this concept in the rest of this section, as the aim is to rather focus on the characteristics of the concept than on the semantics of its naming.*

topics on the internet (Noruzi 2006). Also, with bookmarking, tagging helps to counter the spam-induced noise in search engines, and with photo and video sharing, tagging helps to improve the precision and recall of search engines (Gruber 2005). Some popular Internet services which make use of tagging are Del.icio.us (a bookmarking service), Flickr (a photo sharing service) and YouTube (a video sharing service)[12] (Stock 2007).

For a better understanding of the manner in which tagging can be applied, one can consider the following functions performed by tags (specifically for bookmarking), which were identified by Golder & Hubermann (2006):

1. Identifying what (or who) the specific content is about: An overwhelming majority of tags fulfil this function, and include common nouns of many levels of specificity, as well as proper nouns (specifically when describing people or organisations).
2. Identifying what the specific content is: Tags can be used to identify what type of content the specific bookmarked item is, in addition to what it is about, like *article, blog* and *book*.
3. Identifying who owns the specific content: Some content are tagged according to who owns or created it.
4. Refining categories: Certain tags are not used alone and, rather than establishing categories themselves, are used to refine or qualify existing categories (like *25* and *100*).
5. Identifying qualities or characteristics: Adjectives such as *scary*, *funny*, *stupid* and *inspirational* is used to describe the tagger's opinion of the specific content.
6. Self Reference: Tags such as *mystuff* and *mycomments*, aimed at identifying content in terms of its relation to the tagger.
7. Task organising: When collecting information related to performing a task, that information might be tagged according to that task, in order to group that information together (examples include *toread* and *jobsearch*).

A mechanism that further increased the usefulness of tagging is the *tag cloud*, which is an interface element commonly associated with folksonomy datasets (see an example of a typical tag cloud in Figure 4.10). Sinclair & Cardew-Hall (2007) provides the following explanation of a tag cloud:

'A tag cloud (more traditionally known as a *weighted list* in the field of visual design) is a visual depiction of content tags used on a website. Often, more frequently used tags are depicted in a larger font or otherwise emphasized, while the displayed order is generally alphabetical. Thus both finding a tag by alphabet and by popularity is possible. Selecting a single tag within a tag cloud will generally lead to a collection of items that are associated with that tag.'

[12] http://del.icio.us/, http://www.flickr.com/, http://www.youtube.com/

Figure 4.10: An example of a tag cloud (Source: Everyone's Tags 2007)

It is obvious that the concept of the folksonomy (or more generally, the notion of tagging), is very well suited to provide users with the information they require in a manner that is familiar to them. Its novel approach (letting the actions of users determine the structure of information rather than the ideas of a select group of dedicated professionals) appeals to users, but has some shortcomings, such as that it does not enforce precision, may have difficulty with distinguishing between different languages and has no control over synonymy and homonymy (Stock 2007); problems which other approaches have much less difficulty to address. Its benefits however (such as providing an authentic representation of the language used by a specific community (Quintarelli, cited in Stock 2007), allowing for multiple interpretations of information used by the same community (Peterson, cited in Stock 2007) and providing an environment for serendipity to take place (Mathes 2004)), make it far too valuable to discard, which has led some individuals to suggest that it should be used in conjunction with existing (and more structured) methods, which will yield much more complete solutions for information structuring and retrieval (an example of such an integrated solution can be seen in Figure 4.11, which depicts an information environment in which the functionality of ontologies, text-oriented methods and folksonomies are integrated). As the folksonomy concept matures, the robustness of implementations will improve, and will naturally cause the concept to be implemented much more extensively.

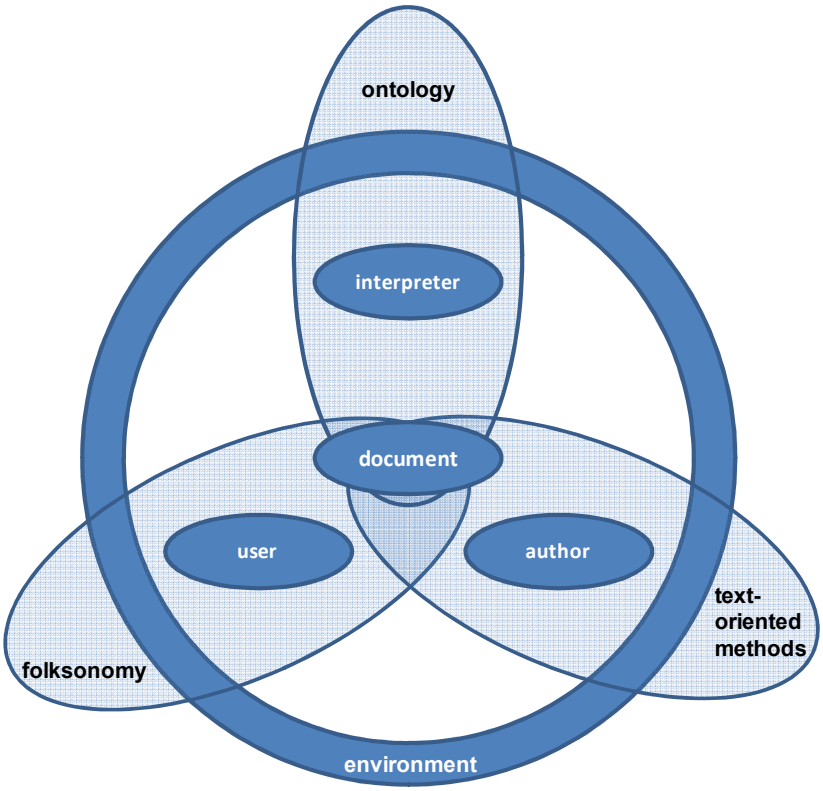


Figure 4.11: An example of an information environment in which the functionality of ontologies, text-oriented methods and folksonomies are integrated (Source: Stock 2007)

4.2.6 Concept maps

- ***Concept***

A concept map is a two-dimensional representation of a set of concepts that is constructed so that the inter-relations among them are evident (Carvalho, Hewett & Cañas 2001), and is aimed at providing a means for people to easily organise and represent knowledge for improved understanding (Novak & Cañas 2006). It consists of concepts (a concept defined by Novak & Cañas (2006) as being 'a perceived regularity in events or objects, or records of events or objects, designated by a label'), and the relations that exist between the concepts (typically specified by linking words or linking phrases). Concept maps represent meaningful relations between its concepts in the form of *propositions*. Propositions are statements about some object or event in the universe (either occurring naturally or having been constructed), each containing two or more concepts which are connected through linking words or phrases (i.e. relations) to form meaningful statements. Propositions are also sometimes called semantic units, or units of meaning (Novak &

Cañas 2006). An example of a concept map (created by NASA for Mars Exploration (Novak & Cañas 2006)) can be seen in Figure 4.12.

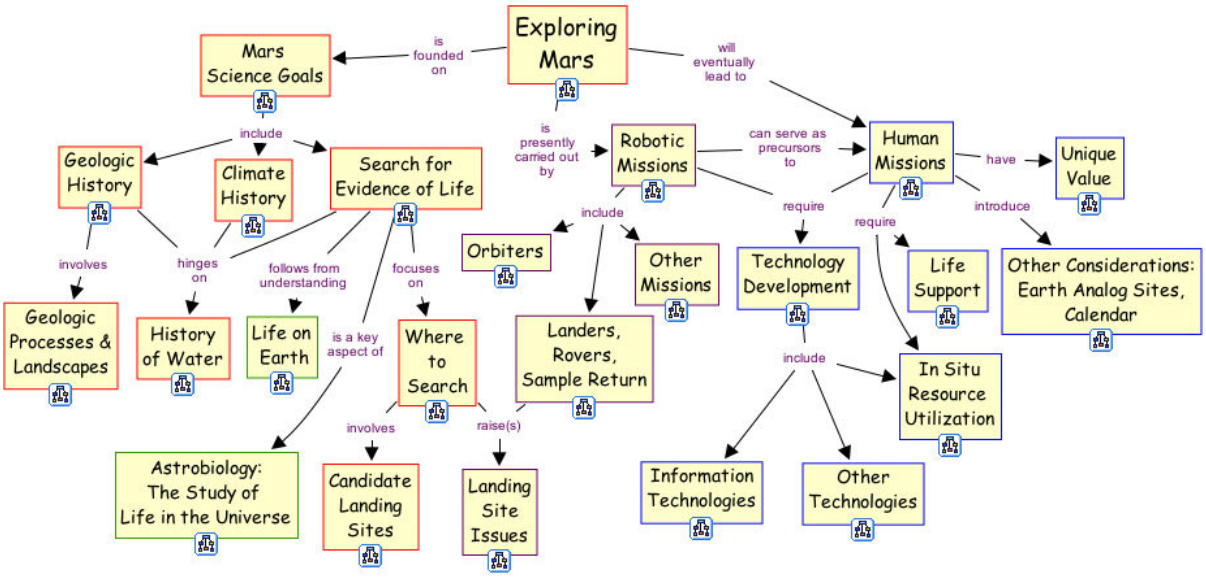


Figure 4.12: An example of a concept map (Source: Novak & Cañas 2006)

Concept maps is structured mainly in a hierarchical fashion, with the most inclusive, most general concepts at the top of the map, and the more specific, less general concepts arranged hierarchical below. Context however, also plays a major role in the structuring of concept maps, and therefore they are generally constructed to answer a specific question (called a focus question), which provides a guideline as to the manner in which knowledge in the concept map should be structured. The context of concept maps is further enhanced through the use of cross-links, which are relations between different segments or domains of the concept map. Cross-links aim to providing insight in the manner in which concepts in different domains of the concept map are related. Finally, specific examples of events or objects may also be added to concept maps in order to clarify the meaning of certain concepts (Novak & Cañas 2006).

Additional to an obvious ability to improve understanding by representing knowledge in a visual manner, concept maps are specifically targeted to act as visual languages. Visual languages are similar in their characteristics to natural language text, in that syntactic and semantic constraints can be applied to them, and their representation capacity can range from fairly informal to extremely formal. Being a visual language that is both comprehensible and formal, concept maps are able to be effectively utilised for both comprehension and editing, and also for parts of the knowledge acquisition process itself (Gaines & Shaw 1995). It is furthermore well suited for the generation of new knowledge, as experts who build concept maps are empowered to not simply externalise pre-existing internal knowledge but also, through phases of comparison and consideration, perform knowledge construction (Leake, Maguitman & Cañas 2002).

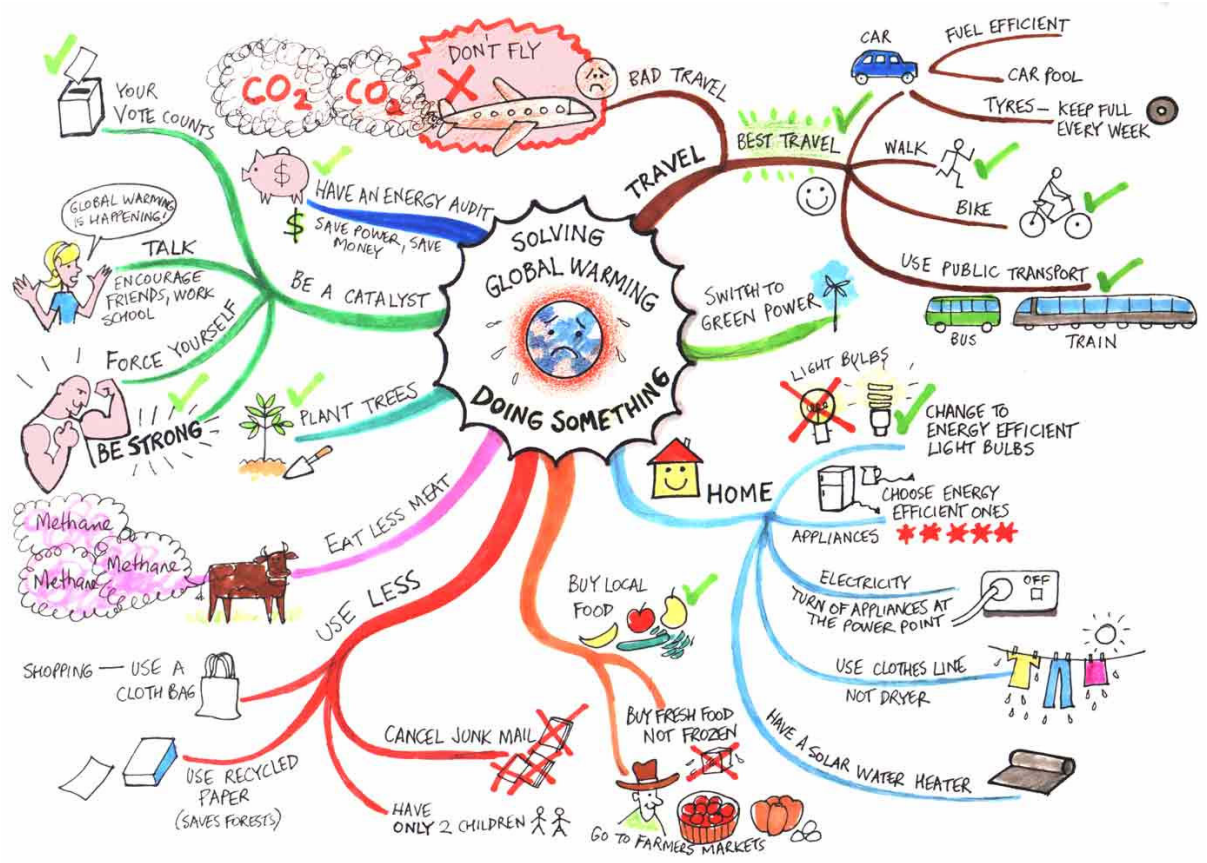


Figure 4.13: An example of a mind map (Source: Combating Global Warming Mind Map 2007)

4.2.7 Topic maps

- ***Concept***

The topic map concept is an ISO standard (ISO/IEC 13250:2003) developed for the representation and interchange of knowledge (Wikipedia, the free encyclopedia 2007f) which specifically focuses on improving the "retrievability" of information. This is done by the topic map acting as a superimposed external layer, aimed specifically at describing the nature (i.e. subject) of the knowledge represented in specific information resources (as opposed to metadata which only really describes the characteristics of the information sources) (Biezunski & Newcomb 2001). It can almost be understood as 'a semantic net stretched over the actual information resources' (Mertins, Heisig & Vorbeck 2005). Being external to the information sources, means that there are no real limitations to the kinds of information that can be described by topic maps. With the ability to describe the nature of knowledge, also comes the capability to identify similar concepts in disparate information objects and, based on this similarity, to associate all the objects relevant to a specific concept with one another (Biezunski & Newcomb 2001).

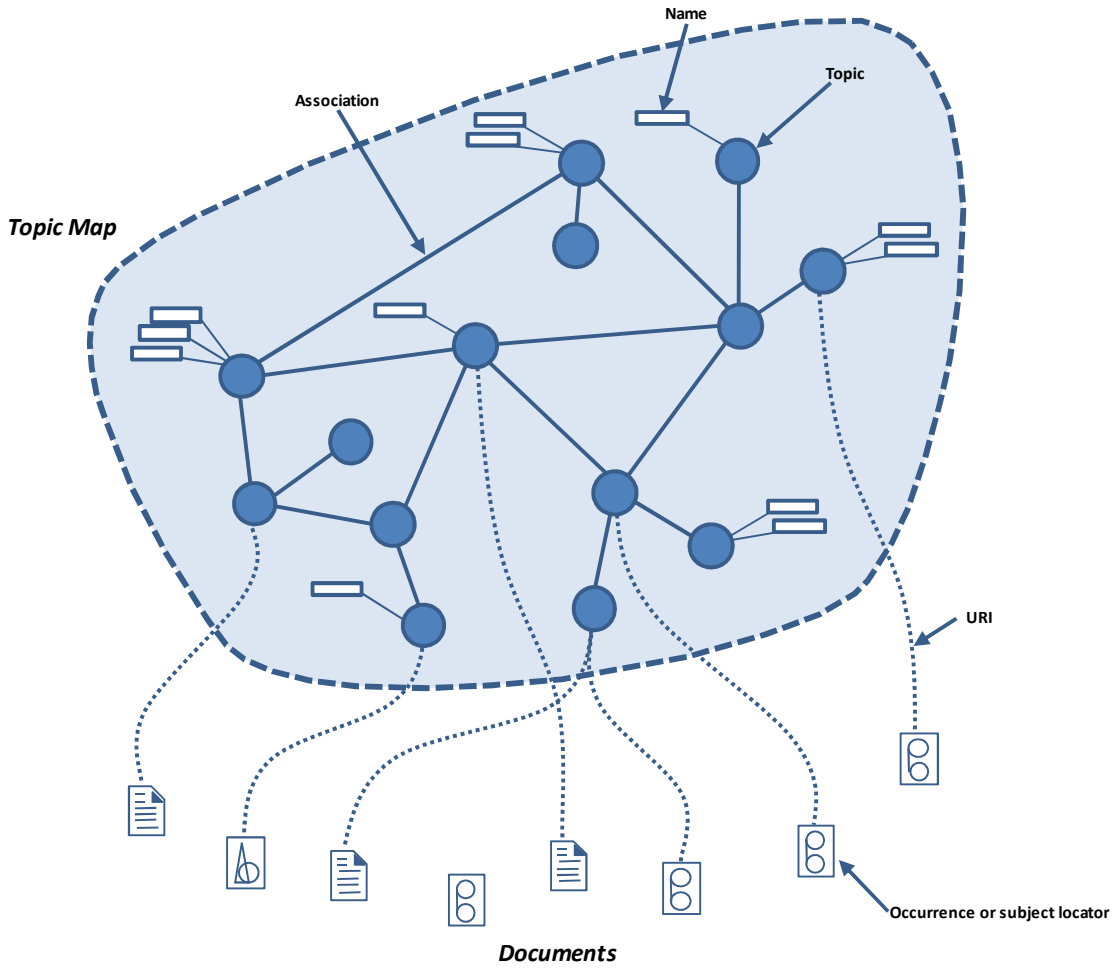


Figure 4.14: The components of a topic map (Source: Topic Map Example 2007)

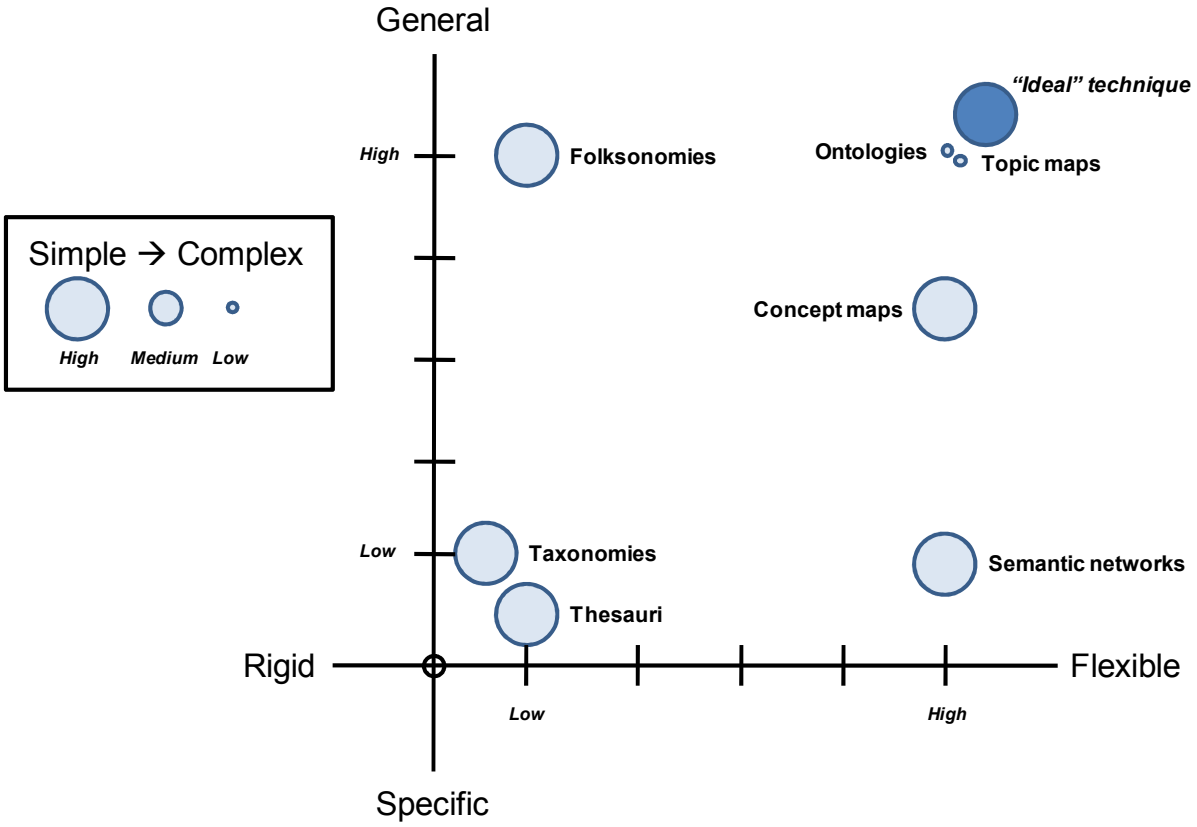
Finally, topic maps make use of the following concepts for control and ease-of-use purposes:

- Types: Topics, associations and occurrences can all be typed (Biezunski & Newcomb 2001; Pepper 2002), with topic, association and occurrence types[13] also being topics. It is a powerful means to perform classification and grouping of topic map elements, and allows a topic map user to better describe the world from which the topics are taken (Garshol 2004). If necessary, it is ideal for structuring topics in hierarchical or any other type of structure aimed at improving users' understanding of the topic map.

- Scope: In order to address the problem of context, topics and their associated characteristics and associations can be defined to only be valid within certain limits, which may or may not be specified explicitly (Pepper 2002). These limits (i.e. scope) act as a filtering mechanism, ensuring that only information relevant to the user is displayed. Just some of the ways in which scope can be applied to the information in a topic map is the modelling of different

[13] *Rath (2003) refers to types used by topic maps as "classes", but the ISO 13250 standard uses the term "type", which is also preferred in this document.*

effective manner. Figure 4.15 shows a comparison between these techniques in terms of three measures, namely generality (i.e. does the technique cater for a specific need, or can it be applied in a variety of different manners), flexibility (i.e. does the technique lend itself toward having its structure configured to address a specific need, or does it have a set structure), and simplicity (i.e. how easy do users find the approach to understand and interact with). The rationale behind the placement of the techniques on the coordinate system is as follows[14]:



Technique	Generality	Flexibility	Simplicity
Semantic networks	Low	High	High
Thesauri	Low	Low	High
Taxonomies	Low	Low	High
Ontologies	High	High	Low
Folksonomies	High	Low	High
Concept maps	Medium	High	High
Topic maps	High	High	Low
"Ideal" technique	**HIGH**	**HIGH**	**HIGH**

Figure 4.15: Comparison of information modelling techniques in terms of generality, flexibility and simplicity

[14] *Interestingly enough, none of the techniques (except for Concept maps) appear in the medium ranges of the landscape, which gives the impression that the development of these techniques is generally focused on addressing specific needs, and not on providing solutions that partly address a large variety of needs.*

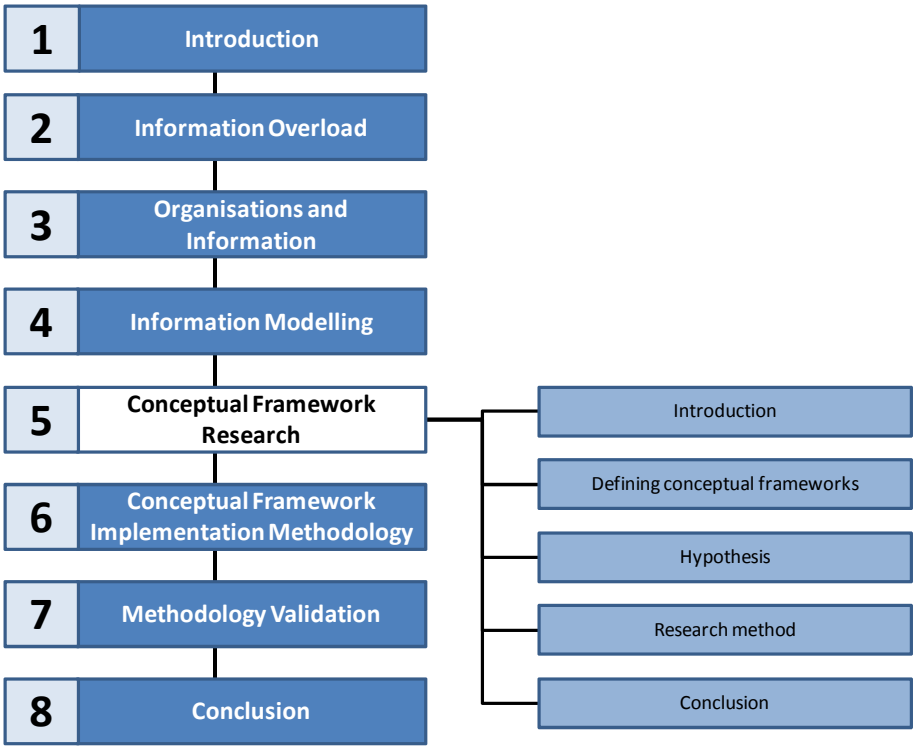


Figure 5.1: Image for navigating thesis and chapter 5

5.2.1 Concept

The Hypothesis Browser website of the Huck Institute for Life Sciences, Penn State University (HyBrow n.d.) defines a conceptual framework as follows:

> 'A conceptual framework is a formal way of thinking (i.e. conceptualising) about a process/system under study.'

It can therefore signify a mechanism or construct used by a person to increase his/her understanding of a certain process, system or (in this case) collection of information. This is however, a very general definition. The conceptual framework concept, on which research is being conducted by the GCC and Indutech, was defined by Uys (2005) as:

> 'A formal model of a given domain, consisting out of the domain entities and the relationships holding among these entities, used for understanding and analysing the domain in question.'

This is still a very general definition which sufficiently defines a number of already existing information modelling approaches (some of which are discussed in Chapter 4). While this is currently a sufficient definition for the purposes of the GCC, a more specific definition is however required for the purpose of this thesis, to distinguish conceptual frameworks from approaches such as concept maps, ontologies and topic maps. A fact which distinguishes the conceptual framework from most information modelling approaches is that in the development of the conceptual framework approach, great emphasis was placed on simplicity. In a conceptual framework, only four concepts are utilised: entities, relations, facts, and types, and the application of the conceptual framework approach is based on certain accepted assertions about these four concepts. The extended definition that will be used in this thesis to describe a conceptual framework is therefore as follows:

'A conceptual framework is a formal model of a given domain, consisting of domain entities and relations that have been identified between these entities. The construction of a conceptual framework is based on only four concepts, namely that of entities, relations, facts and types, which provide the means for improved understanding of the domain in question through visual browsing and navigation of these concepts.'

The concepts of conceptual framework entities, relations, facts and types (within the scope and focus of this thesis) will forthwith be discussed.

- ***Entities***

A conceptual framework *entity* is defined as follows:

An entity is a reference to any specific thing, real or abstract, that forms part of, or has any importance in, a particular information environment. It is represented by a commonly-used label that corresponds to the perception of the real-world aspect which the entity represents.

Entities are the building blocks used to construct a conceptual framework, and typically represents the aspects encountered in a person's (or group of persons') daily environment, for example, "Howard Shore" (which may denote a person), "Budget2005.xls" (which may denote a document), "Procurement" (which may denote a department within an organisation) and "Dubai" (which may denote a geographical location). Additionally, a rather unique feature of the conceptual framework approach which is quite uncommon in other information modelling techniques is the fact that references to real or abstract features of entities that exist in the information domain (i.e. attributes) are considered as entities themselves, rather than as attributes which, in the case of other conventional information modelling approaches, might be seen as information with reduced

importance to the information domain. This means that entity features such as “80” ((kg) i.e. a measure of weight), “15” ((min) i.e. a measure of duration) and “17” ((km) i.e. a measure of distance) are also regarded as entities. This increases the diversity of the environment under consideration, which is useful when searching for specific information.

- ***Relations***

A conceptual framework *relation* is defined as follows:

Any association between two entities represented in a conceptual framework is represented by a relation, which is a text string that states the manner in which the two entities are associated. A relation is not required to be unique to a pair of entities, and may be reused to describe the relation between any number of relevant entity pairs.

Consider the following example: If two entities exist, one denoting a person “Howard Shore”, and one denoting a document “Budget2005.xls”, then a relation indicating that the person “Howard Shore” created the document “Budget2005.xls”, might be “is person who created document” (see Figure 5.2).

Entity	Relation	Entity
Howard Shore	is person who created document	Budget2005.xls

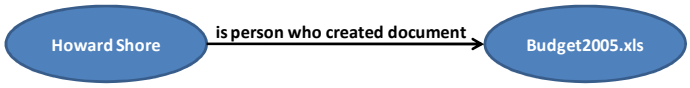


Figure 5.2: An example of a relation between two entities

Relations can be defined very specifically to describe the association between only two entities, or may be defined in a general manner as to be applicable to groups of entities (see also the next section, Types), for instance, in a conceptual framework containing a number of entities denoting persons and documents, the relation “is person who created document” might be applied between various person-document entity pairs, and will successfully convey that specific information.

The construct created through the joining of two entities by means of a relation, is known as a *fact* (defined as follows):

The joining of two entities by means of a relation (i.e. entity-relation-entity) produces the smallest unit of information found in a conceptual framework, known as a *fact*.

When considered on its own, a fact is the smallest unit of information that exists in a conceptual framework, and is deemed to be a truthful representation of some part of the world being modelled

by the conceptual framework. Facts are by implication multi-directional, and can also be grouped together to form *complex facts*. An example of a complex fact may be to state that "Budget2005.xls" (a document) was created by "Howard Shore" (a person) who works in "Procurement" (a department). This fact, which consists of three entities and two relations (and also illustrates the multi-directionality of facts), is actually a combination of the information contained in the two facts: (department) "Procurement" is the department of person "Howard Shore", and (person) "Howard Shore" is the person who created document "Budget2005.xls" (see Figure 5.3).

Entity	Relation	Entity
Procurement	is department of person	Howard Shore
Howard Shore	is person who created document	Budget2005.xls

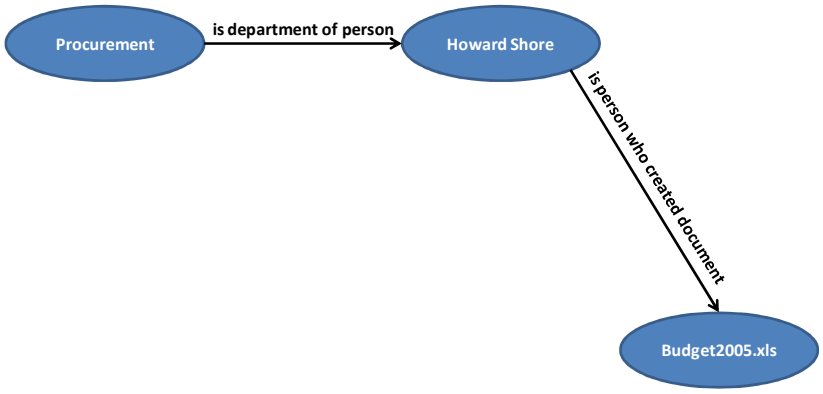


Figure 5.3: An example of a complex fact

- ***Types***

Conceptual framework *types* can be seen as units of classification within an information domain, and is formally defined as follows:

Multiple entities may be grouped together through the relation of each entity to a classification entity – known as a type – by means of an "is a"-relation. Relations can also be specified between types, and are propagated to the children of those types, although the use of inherited relations is not mandatory.

Although not mandatory, types are usually employed to group entities together based on some common characteristic shared between them. As indicated in the definition, a type is identifiable in a conceptual framework by being connected to its children entities through an "is a" relation. For example, a type "Person" can be defined for all entities signifying person-like characteristics, a type "Department" for all department-like entities, and so on (see Figure 5.4).

Entity	Relation	Entity
Procurement	is a	Department
Engineering	is a	Department
Howard Shore	is a	Person
Peter Jackson	is a	Person
Peter Jackson	is a	Manager

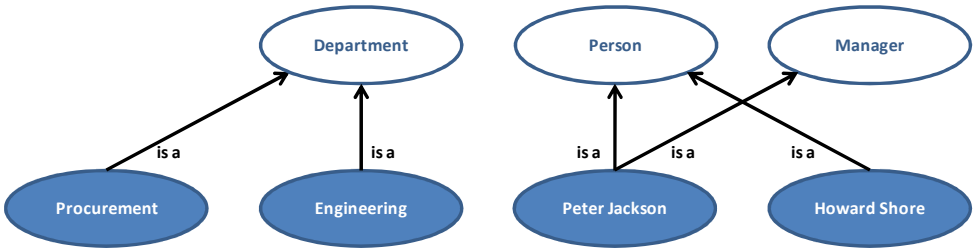


Figure 5.4: An example of types

Types are not mutually exclusive, which means that an entity may belong to more than one type. Relations can be defined between types, which give an indication of associations that can be assumed between different groups of entities. These relations are then also propagated to the children of the types, although the entities are not restricted to the relations of the types they are associated with. This is very apparent when one considers the conceptual framework represented in Figure 5.5.

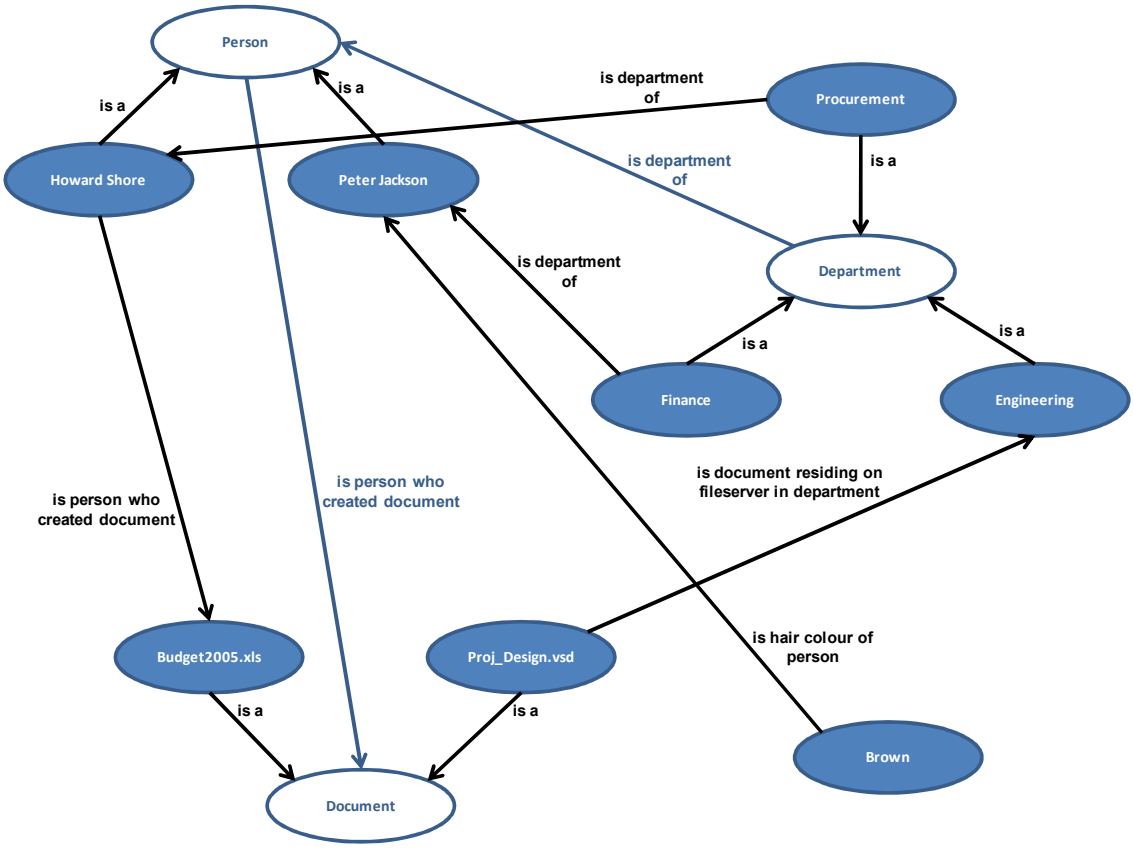


Figure 5.5: An example of a conceptual framework

conceptual frameworks address this aspect, in that the inheritance of relations defined in a conceptual framework are not mandatory, and a much larger variety of relations are allowed.

- An ontology is one of the approaches that corresponds very closely to the definitions constituting the conceptual framework concept. Although ontology concepts are initially organised in a hierarchical structure, this by no means limits the manner in which different concepts can be related to each other. It therefore utilises the entity-relation-entity construct in much the same way that conceptual frameworks do. An aspect that ontologies employ, which conceptual frameworks do not, is the use of constraints and axioms that restricts the manner in which information is represented in the ontology. This is however a control feature employed to enhance the user-experience of ontologies, and from the point of view of this discussion not seen as part of the core features of ontologies. Ontologies also add an additional dimension to its objects by allowing the definition of attributes that describe the objects. This is not allowed by conceptual frameworks, as the impression is created that attributes are information of lesser value than the concepts they describe, which may result in a biased view on the domain being presented to the user, or that important relations that exist in the domain may be overlooked.
- The folksonomy approach typically makes use of only three fixed types – users, tags and (information) objects. On closer inspection it becomes apparent that these types and entities of these types are related in a fixed manner to any of the other two types and entities of these types (see Figure 5.6).

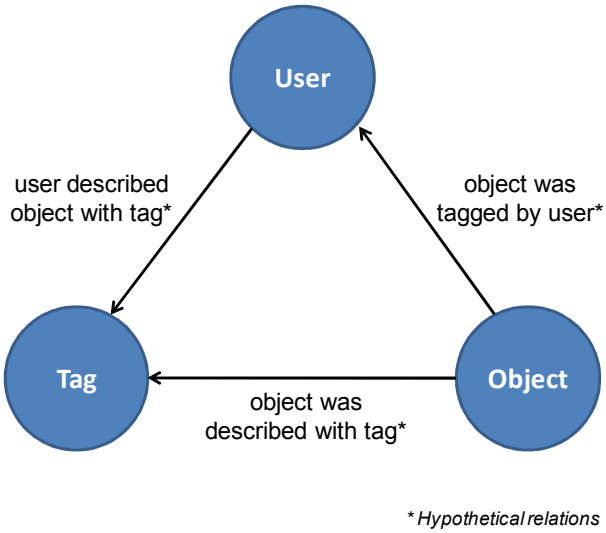


Figure 5.6: Relations that exist between different types in a folksonomy

There therefore exists no freedom in the definition of relationships between types. Also, to express the association that exists between entities of the same type (e.g. between two objects, two tags or two users) in a sensible manner, entities of the remaining types are required to indicate the relation. For example, to express the relation between two objects, one should

consider the tags that are shared between the two objects, as well as the users that have tagged or accessed both of the objects (see Figure 5.7).

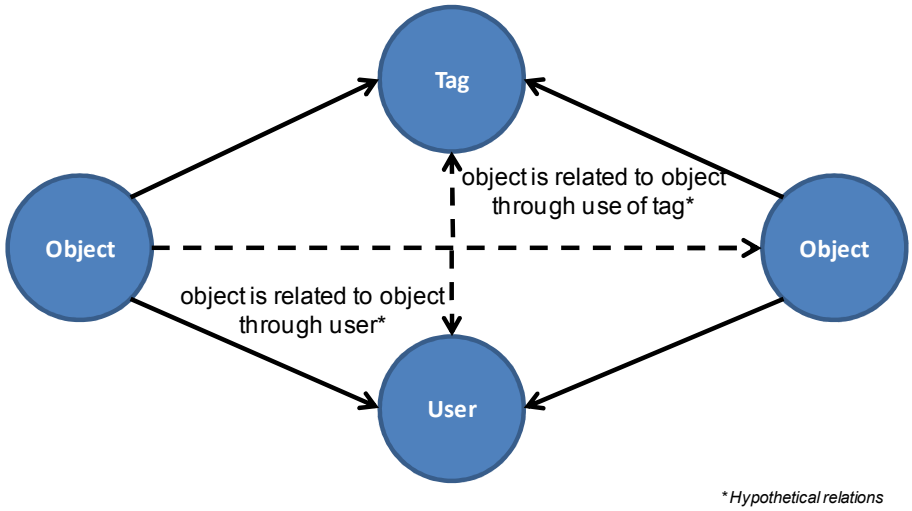


Figure 5.7: Example of relation between types of the same kind in folksonomies

These may be seen as complex facts in the conceptual framework context. Other than that, due to the fact that both the types and relations that exist within folksonomies are fixed, a folksonomy is a very restricted version of the conceptual framework approach.

- At first glance, concept maps seem to be an exact manifestation of the conceptual framework concept, as it seemingly also makes use of the four concepts that forms the core of conceptual frameworks, namely concepts (i.e. entities, see section Entities), relations, propositions (i.e. facts, for both see section Relations) and general concepts (i.e. types, see section Types). There are however subtle differences: Even though concept maps are hierarchical in structure, this does not imply that concept maps make use of types – concept map concepts that are placed higher up in the hierarchy are simply events or objects that represent more general concepts that those on the lower levels. Furthermore, concepts in concept maps do not necessarily represent actual aspects found in an information domain – it merely serves to improve the human understanding of the domain under consideration.

- Of all the approaches discussed in this document, topic maps are possibly the most similar to conceptual frameworks. Entities (or topics), relations (or associations), types and facts are all supported by topic maps, and in some cases the topic map approach even provides more functionality than the conceptual framework approach (e.g. the typing of associations and occurrences). Strictly speaking, this may mean that topic maps can actually be considered a sister class of conceptual frameworks rather than a subclass. It has however been determined that, due to the large variety of functionality offered by the topic map approach, a topic map is much less simple and intuitive to construct and interact with than a conceptual framework, which is a slight advantage that the conceptual framework approach have over that of the topic

map (and especially relevant in the case of users with a limited understanding of information modelling and representation).

For a summarised comparison between the conceptual framework approach and the other information modelling approaches mentioned in this section, see Table 5.1.

Table 5.1: A summarised comparison between conceptual frameworks and other information modelling approaches

Information Modelling Approach	Conceptual Framework Concepts				Differences from Conceptual Frameworks
	Entities	Relations	Facts	Types	
Semantic Network	Yes	Yes	Yes	No	Employed singularly for the clarifying of a specific language, i.e. does not attempt to describe a domain in its entirety.
Thesaurus	Yes	Restricted	Yes	No	Employed singularly to indicate the manner in which terms that exist within a specific language are related, i.e. does not attempt to describe a domain in its entirety.
Taxonomy	Yes	Restricted	Yes	Yes	Employed singularly to indicate the "natural" hierarchy that exists within a group of concepts. Mandatory inheritance of relations.
Ontology	Yes	Yes	Yes	Yes	"Soft" hierarchical structure. Constraints and axioms restrict the information represented by ontology. Allows definition of attributes that describe ontology objects.
Folksonomy	Yes	Restricted	Yes	Restricted	Fixed types and relations.
Concept Map	Yes	Yes	Yes	No	Does not make use of types – only distinguishes between more general and more specific terms. Is not necessarily aimed at describing a domain, but rather at improving understanding.
Topic Map	Yes	Yes	Yes	Yes	Great complexity which impacts on ease of construction and interaction.
Conceptual Framework	Yes	Yes	Yes	Yes	

5.2.3 Application

Through application in different scenarios at both the GCC and Indutech, it has become apparent that conceptual frameworks are very useful in representing information in a manner that reduces the time required to gain a full understanding of certain information.

When considering the modelling of information as a conceptual framework, there are two aspects to be considered that influences the manner in which conceptual framework construction takes place. The

representation of information as graphs formed the basis of the development of Organon, a software application that was developed by Indutech as a tool for creating, navigating and editing conceptual frameworks. Organon visualises conceptual frameworks as network graphs, in which entities and types are represented as nodes and relations are represented as arcs. Currently, it is the only known software application through which conceptual frameworks can be created, updated and navigated, and is employed by the GCC and Indutech for conceptual framework applications and research. A screenshot of a conceptual framework visualised by Organon can be seen in Figure 5.8.

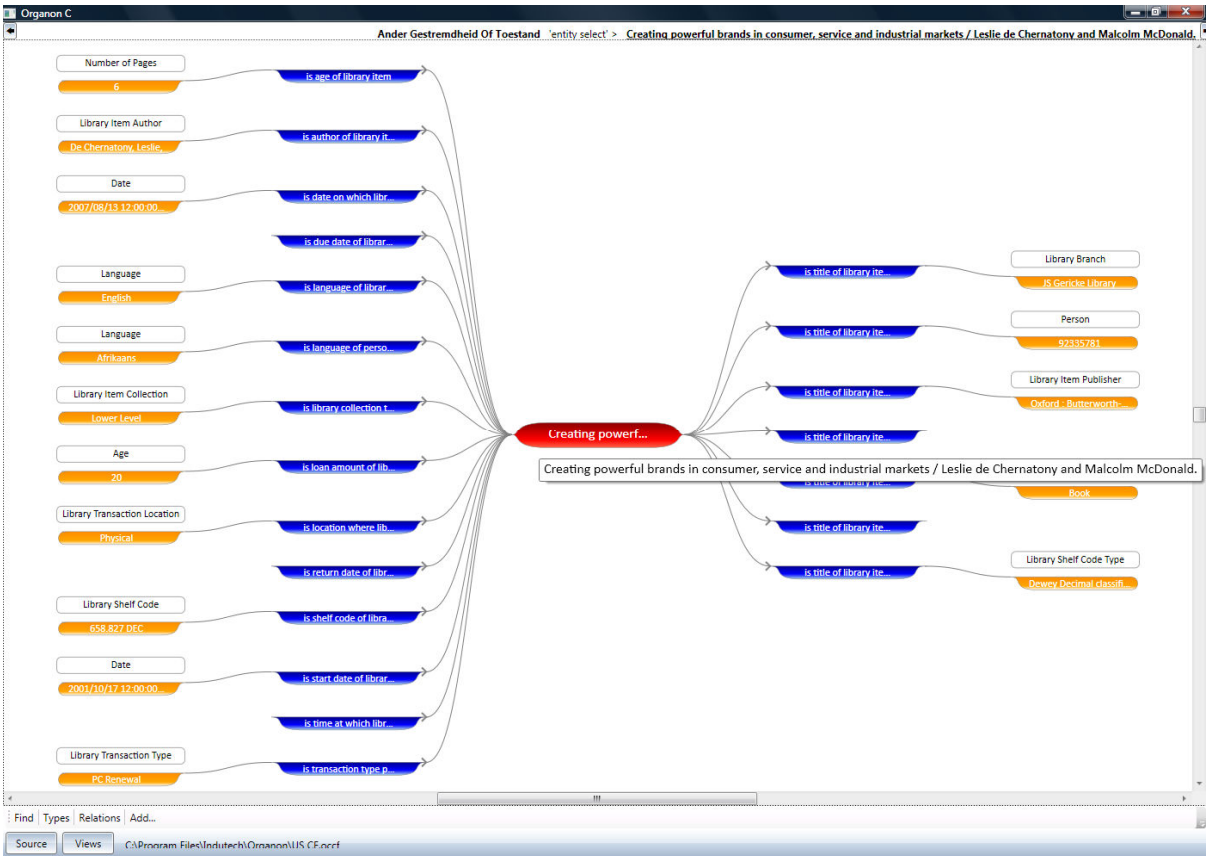


Figure 5.8: Screenshot of Organon

Organon was used in the research that is discussed by this document. Information on the manner in which it was applied can be found in Chapter 7, and other information on the software itself can be found in Appendix A.

5.2.5 Conceptual framework research

The concept of conceptual frameworks introduced in this chapter is currently still a largely experimental approach for modelling information in a very simple and unconstrained manner. A number of research efforts are currently underway that investigate the different manners and scenarios in which conceptual frameworks can be applied, the value that will be experienced by users that interact with conceptual

frameworks, as well as its overall value to the fields of information management and knowledge management. Current conceptual framework research efforts are effectively divided into two main streams, namely the representation of structured information and the representation of unstructured information for improved understanding (see Figure 5.9).

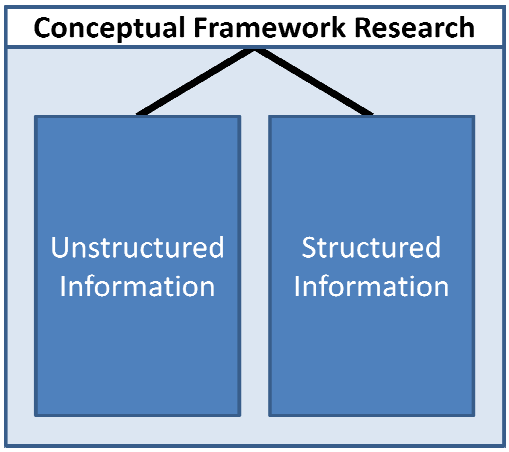


Figure 5.9: Conceptual framework research streams

The research presented in this document focuses on the application of conceptual frameworks to *structured information*, and contributes specifically to research aimed at establishing the worth of conceptual frameworks as decision-making tools within organisations. The hypothesis and method of research for this research is provided in the remainder of this chapter, which is followed by the research outputs (Chapter 6), information on case studies that were performed as part of the research (Chapter 7) and conclusions reached based on the research (Chapter 8).

5.3 Hypothesis

Research on conceptual frameworks has progressed to a stage where its applicability in organisations should be investigated. As a starting point for this investigation, it was deemed useful to develop a methodology through which a conceptual framework can be implemented in an organisation. Such a methodology would be required to address the following aspects of conceptual framework application:

- Development of a conceptual framework specification based on stakeholder inputs and analyses of organisational information sources;
- Creation and population of the conceptual framework with organisational data;
- Management of the information system issues when implementing the conceptual framework as an operational business tool (e.g. bandwidth, network privileges, storage, etc.);

- Management of user issues, such as security and training; and
- Establishment of a strategy for growing the conceptual framework in the organisation.

Once developed, the completeness and relevance of the methodology would be assessed through testing of the following hypothesis:

Hypothesis:	**Information represented by a conceptual framework implemented through the use of the developed conceptual framework implementation methodology, offer a truthful view on information found in an organisation.**

5.4 Research method

The main outcome of the research was a tried-and-tested methodology developed for the implementation of a conceptual framework in an organisation. Indutech (in conjunction with which the research was conducted) furthermore experienced additional benefit from the project, in that it was provided with opportunities through which Organon, the conceptual framework software tool developed by Indutech for the viewing and editing of conceptual frameworks (see section 5.2.4, Chapter 7 and Appendix A), could be tested and improved. This is however not a formal outcome of the research, and will therefore not be discussed.

The process that was followed in the development of the conceptual framework implementation methodology took place in the following manner (see Figure 5.10):

1. An initial version of the methodology was developed, based on knowledge gathered on conceptual frameworks through research conducted by the GCC and Indutech.
2. Once there was agreement on the completeness and usability of the methodology, a case study was conducted in order to ascertain the effectiveness of the methodology in implementing a conceptual framework at an organisation. Indutech was selected as the case study site, due to the fact that it is already heavily involved in conceptual framework research, and therefore provided a benign testing environment where most of the methodology's creases could be smoothed out.
3. After concluding the case study, all information gathered during the course of the implementation was used to refine the methodology and make improvements to the Organon software.
4. Once the modifications were made, a second case study was conducted to further refine the methodology. The site selected for the second case study was the Information Technology division of Stellenbosch University.

5. Upon completion of the second case study, observations and lessons learned resulted in another round of improvements made to the methodology and to Organon.

6. The second round of improvements ultimately yielded a conceptual framework implementation methodology that was deemed fit to be utilised as a tried-and-tested tool for the implementation of conceptual frameworks in organisations. This was done based on feedback from the GCC and Indutech research personnel who were involved in the case studies, and the organisational users of the Organon software at each of the case study sites (who also had to decide whether the hypothesis on which this research effort was focused was true or not).

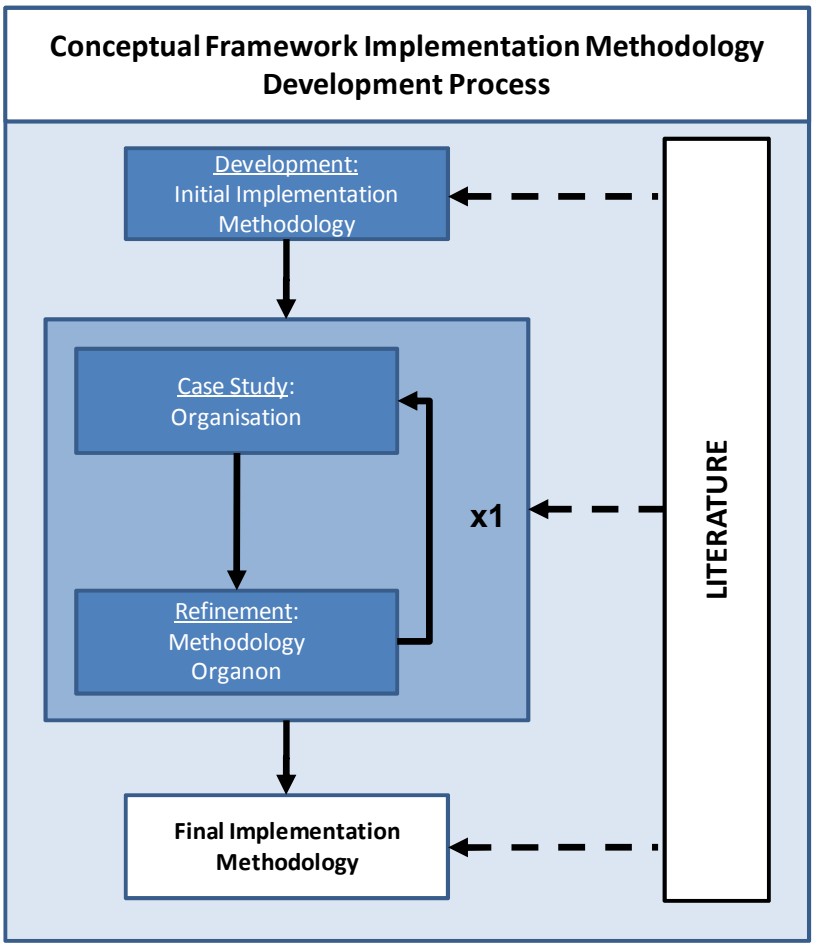


Figure 5.10: Conceptual framework implementation methodology development process

The use of literature served a supporting role throughout the entire conceptual framework methodology development process, and was specifically employed in the conducting of a literature study on information overload, information use in organisations, and other existing information modelling approaches (see Chapters 1 - 4), as well as in the validation of the methodology through comparison with other similar information modelling approach implementation methodologies (see Chapter 7).

Chapter 6 – Conceptual Framework Implementation Methodology

6.1 Introduction

The previous chapter (Chapter 5) introduced the concept of a conceptual framework based approach for the representation of information. It further discussed a research project that was conducted in the field of conceptual frameworks (focused specifically on the representation of *structured* information) through which a methodology for the implementation and maintenance of a conceptual framework in an organisation was developed. This chapter introduces and discusses this methodology. An image depicting the structure of this chapter is displayed in Figure 6.1.

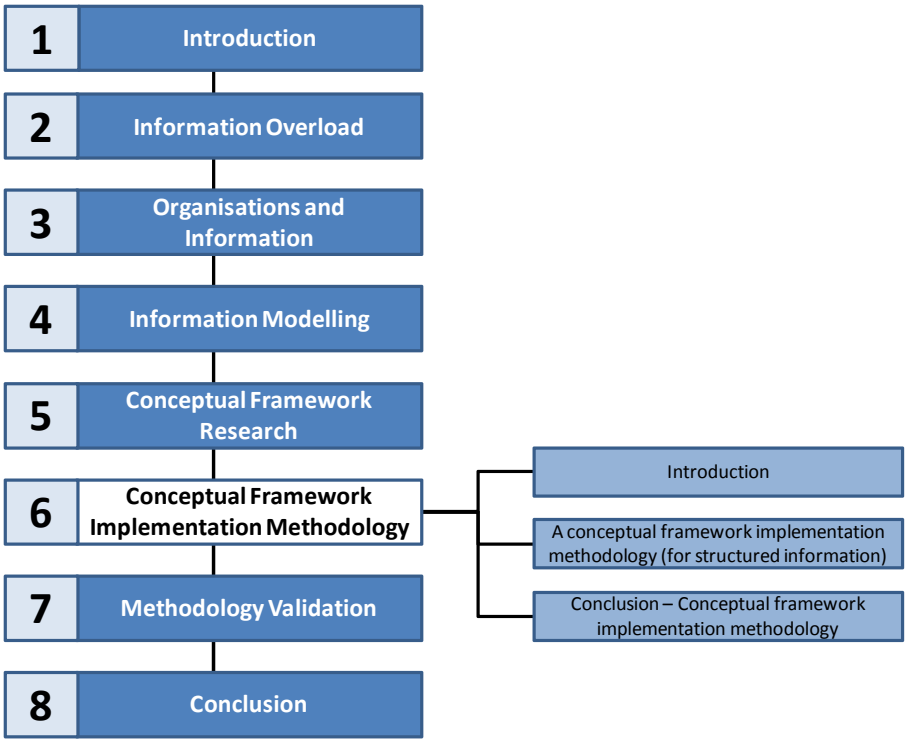


Figure 6.1: Image for navigating thesis and chapter 6

6.2 The proposed methodology[17]

The conceptual framework implementation methodology for structured information (see Figure 6.2) is a top-down process that is comprised of five phases, namely Planning, Analysis, Development, Implementation and Maintenance. Each of the phases consists of a number of activities that should be executed in order to ensure the quality of the conceptual framework and the eventual success of the implementation. For each of these phases and activities, the following aspects will be addressed in this discussion of the implementation methodology:

- The rationale behind the phase or activity;
- Prerequisites or inputs of the phase or activity;
- The execution of the phase or activity; and
- Outputs of the phase or activity.

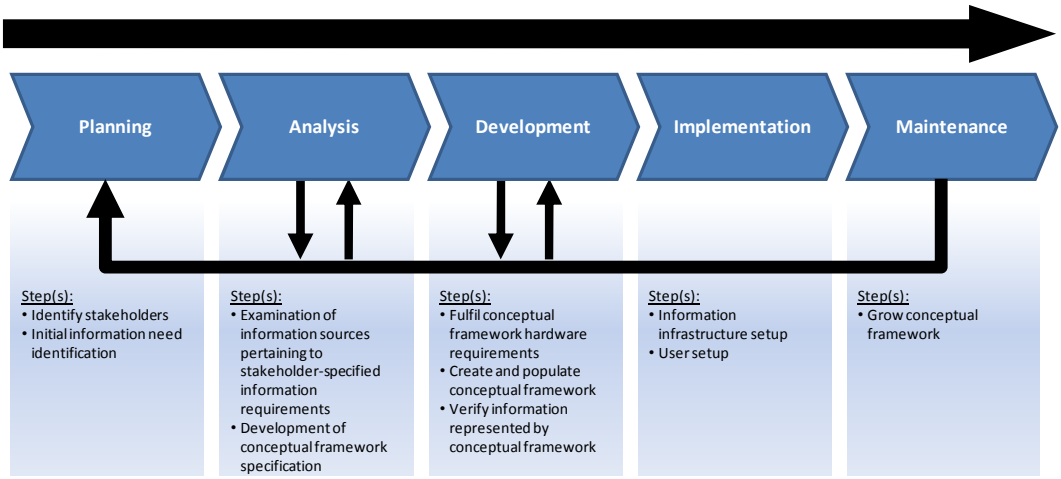


Figure 6.2: The Conceptual Framework Implementation Methodology for Structured Information

The phases of the methodology will forthwith be discussed.[18]

[17] *Or more formally: "A conceptual framework implementation methodology (for structured information)".*

[18] *The numbering system that will be used in the methodology discussion will differ from the numbering system employed in the rest of this thesis. Each phase will simply be designated by a letter based on its position in the sequence of phases that constitute the implementation methodology (e.g. "A" = Planning, "C" = Development, etc.). Each activity will have a designator composed of the indicator of the phase it forms part of, and a number that identifies the activity within the particular phase, based on its order of execution. For example, "C2" indicates the "Create and populate conceptual framework" activity of the Development phase.*

A – Planning phase

Designation:	**A**	*Title:*	**Planning Phase**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description:

The first phase of the implementation methodology is aimed at the identification and nomination of stakeholders within the organisation who will be involved in the implementation. The establishing of the implementation scope should also take place, and is mainly determined by the organisational information domain from which the conceptual framework is to be created.

Rationale:

The planning phase is required to ensure that the conceptual framework implementation efforts are focused on the right areas within the organisation, and to establish who the implementation's decision-makers in the organisation will be.

Prerequisites:

- A need for an integrated view on organisational information[19]

Execution:

- **Activity A1 – Identify stakeholders**
- **Activity A2 – Initial information need identification**

[19] *This is not a "formal" methodology prerequisite, but alludes to the fact that a need identified in the organisation for an integrated view on its information gave rise to the conceptual framework implementation.*

Outputs:

- A **"Conceptual Framework Implementation – Planning phase"** document which should be utilised as an information source and control measure in the management of the implementation. The document should contain the following information (which originated from the activities that constitute the Planning phase):
    - The names and contact details of the stakeholders in the conceptual framework implementation (see Activity A1);
    - The rationale behind the conceptual framework implementation (see Activity A1);
    - The information domains within the organisation for which the conceptual framework will be constructed (see Activity A1);
    - Any agreements reached with the information infrastructure stakeholders regarding the organisational information source access, network usage and data extraction that will be required for the conceptual framework implementation to succeed (see Activity A1); and
    - All information requirements provided by stakeholders, which are the main needs that the conceptual framework implementation should aim to address (see Activity A2).

- ***Activities***

Designation:	**A1**	*Title:*	**Identify stakeholders**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description:

This activity facilitates the identification of stakeholders in the conceptual framework implementation methodology, who are responsible for providing input into the design, development and implementation of the conceptual framework, and possess the authority and the means for effectively removing any obstacles that may be encountered during the implementation process.

Rationale:

For effective decision making during the conceptual framework implementation, it is essential to identify persons in the organisation at whom the implementation is aimed, and to stay in contact with them throughout the entire process. This will ensure that the implemented conceptual framework effectively addresses the specific needs of its users.

Prerequisites:

- Project initiation[20]

Execution:

Two distinct types of stakeholders are required for the successful implementation of a conceptual framework; managerial stakeholders and information infrastructure (system) stakeholders.

[20] *This simply alludes to the fact that the implementation had to already have been kicked off for this activity to be executed.*

Identify management stakeholders

The management component of the implementation stakeholders should be made up of the following role-players within the context of conceptual framework implementation:

- Project champion: The project champion is a person within the organisation tasked with promoting the benefits of pursuing the project, while also justifying the investment made by the organisation. This should be a person who is truly confident in the benefits that would result from the project, and have the necessary skill and mandate for effective advocacy of the project, as well as for effective roadblock removal (Withrow 2004). Once instated, the project champion should identify (alone or with the assistance of others) possible areas within the organisation that will provide a suitable domain for a conceptual framework implementation[21]. It would furthermore be beneficial if these areas required an integrated view of organisational information, as this will have a positive effect on the buy-in from other stakeholders in the implementation and the end users of the conceptual framework.
- Managers and decision makers within the implementation domain: Once the areas within the organisation that have been deemed most suitable for the implementation of a conceptual framework have been identified, managers and other decision makers within these areas together with other experts within the organisation who can make a useful contribution to the implementation, should be identified and included as stakeholders of the implementation process. These persons are responsible for determining the scope and deliverables of the implementation, and act as verifiers when sign-off of the information represented by the conceptual framework is required. A requirement of these stakeholders is that they have an adequate understanding of the interrelatedness of information inside the organisation, and are also convinced (or have been convinced by the project champion) of the need for an integrated view of information within the organisation.

Identify information infrastructure stakeholders

As a conceptual framework implementation requires the utilisation of an organisation's information infrastructure, it is imperative that representatives of this function within the organisation are also included as stakeholders in the implementation. These persons should naturally then also have sufficient influence in the organisation to authorise the interaction with information that will be required by those persons performing the conceptual framework implementation. Buy-in from these representatives is of the utmost importance, and if this cannot be obtained, the project champion may be required to escalate this issue to higher levels of management in order to ensure the cooperation of the organisation's information infrastructure department(s). At this stage however, preliminary backing from these representatives is sufficient, as the total

[21] *As this methodology advocates an iterative implementation process, it is not essential that the entire organisation is initially represented by the conceptual framework. An incremental implementation further allows for teething problems and difficulties with regards to internal organisational complexity to be experienced on a smaller scale, which makes it simpler and speedier to correct. This will be discussed in more detail in section E – Maintenance phase.*

extent of the implementation have not yet been determined, and will only be known after the Analysis phase (see section B – Analysis phase). Nevertheless, in backing the implementation, representatives must be made aware that the establishing of an organisational conceptual framework will require information to be extracted from different data sources in the organisation, and that allocation of organisational network bandwidth and scheduling of information extraction from organisational information sources will be required for the development and operation of the organisational conceptual framework.

Outputs:

- Information to be included in the **"Conceptual Framework Implementation – Planning phase"** document (indicated as the output for phase A – Planning phase). The information required is:
    - The names and contact details of the stakeholders in the conceptual framework implementation;
    - The rationale behind the conceptual framework implementation;
    - The information domains within the organisation for which the conceptual framework will be constructed; and
    - Any agreements reached with the information infrastructure stakeholders regarding the organisational information source access, network usage and data extraction that will be required for the conceptual framework implementation to succeed.

Designation:	**A2**	*Title:*	**Initial information need identification**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description:

This activity entails the collection of high-level stakeholder information needs, which acts as a scope definition for the conceptual framework implementation.

Rationale:

The specification of the implementation scope provides a control measure for the process, and will help to ensure that all efforts are focused on the needs of the stakeholders, and not on aspects of the organisation that are irrelevant.

Prerequisites:

- Conceptual framework stakeholder contact information (Activity A1)
- Information on agreements reached (Activity A1)

Execution:

Once the stakeholders of the conceptual framework implementation have been identified (Activity A1), they should specify the information to be included in the conceptual framework. Although this activity can be seen as the scope definition of the conceptual framework implementation, it should be understood that any definition of scope that is attempted at this stage would be done amidst great uncertainty about the amount of effort and time that would be required to perform the implementation. The aspects of the implementation for which sufficient information is available should therefore be defined in an acceptably rigid manner, while aspects which are more vague may be defined in a more general manner and remain so until later in the implementation process when the uncertainty surrounding these aspects has been reduced.

The one aspect that must be extremely clear and on which the stakeholders must decide first, is the domains

of information within the organisation that will form part of the implementation. This is simply a safety precaution and control measure to prevent the implementation from unnecessarily increasing in time and effort (i.e. so-called “scope-creep”). Other than that, it is sufficient (and also preferable) if stakeholders give their information requirements in the form of “fields of interest” rather than as fixed sets of data (e.g. "I want to see account information of clients" as opposed to "Show me a client's name, address, birth date, monthly income and risk to the business”). This generalisation of organisational information requirements will increase the objectivity of the conceptual framework, and prevent it from only showing specific persons’ views of the organisational information. Once the information requests from each of the stakeholders has been obtained, requests that are similar in nature should be grouped together, which will result in a more consistently and coherently defined information need.

Outputs:

- Similar to Activity A1, the output of this activity is information to be included in the **“Conceptual Framework Implementation – Planning phase”** document (indicated as the output for phase A). The information required is:
  - All information requirements provided by stakeholders, which are the main needs that the conceptual framework implementation should aim to address.

B – Analysis phase

Designation:	**B**	*Title:*	**Analysis Phase**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description:

The main objective of the second phase of the implementation methodology is the analysis of information sources pertaining to the implementation domain that was specified in the Analysis phase (see section A – Planning phase), and from which a specification will be developed for the organisational conceptual framework.

Rationale:

Through the Analysis phase, an organisational conceptual framework specification is developed which is used as the basis for the ensuing conceptual framework development and implementation.

Prerequisites:

- Initial information needs as identified by stakeholders (Activity A2)
- Permission of information infrastructure stakeholders to conduct analyses of organisational information and information structures (Activity A1)

Execution:

- **Activity B1 – Examination of information sources pertaining to stakeholder-specified information requirements**
- **Activity B2 – Development of conceptual framework specification**

Outputs:

- The following information that has been generated through the activities that constitute this phase, should be captured in a **"Conceptual Framework Implementation – Analysis phase"** document, which will function as the design of the implementation:
    - The organisational information sources that were identified to provide the source information for the conceptual framework implementation, together with information on the following aspects of these information sources:
        - The content and structure of the information sources;
        - The manner in which the information sources are related;
        - The manner in which the information sources satisfy stake holder information requirements; and
        - The frequency of change in the information sources. (see Activity B1);
    - The conceptual framework types that were identified from the information sources, together with the location of the information represented by these types (preferably down to table-level in the case of a database) and their frequency of change (see Activity B2);
    - The relations that were identified between the conceptual framework types (see Activity B2); and
    - The final type-relation structure of the conceptual framework after refining, also indicating the manner in which types were grouped together to create an integrated view on the organisational information (see Activity B2).

- ***Activities***

Designation:	**B1**	*Title:*	**Examination of information sources pertaining to stakeholder-specified information requirements**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description:

This activity focuses on evaluating the content and structure of the organisation's information sources and determining in what manner the stakeholders' information needs can be satisfied by this information.

Rationale:

Information on the structure and content of the organisation's information sources will be used during the Development phase (see section C – Development phase) of the implementation, specifically when the organisational conceptual framework is populated with information from the specific information sources.

Prerequisites:

- Initial information needs as identified by stakeholders (Activity A2)
- Permission of information infrastructure stakeholders to conduct analysis of organisational information and information structures (Activity A1)

Execution:

Identification and obtaining of access to relevant information sources

The domains identified by the stakeholders for the conceptual framework implementation (see Activity A2) contain certain information sources which could sufficiently address the information requirements they have provided. Discussions with the database and other information infrastructure administrators of these domains are required in order to identify the organisational information sources that would best address the needs

defined by the stakeholders.

Once the applicable information sources have been identified, it is essential that the required security privileges for these sources are obtained in order to gain access to the information that is required for the analysis. Normally, the information infrastructure stakeholders of the implementation would have sufficient authority to grant these privileges, but if not, the project champion should be employed to expedite or even escalate this issue, as it will impact directly on the continuance of the conceptual framework implementation. Should it happen that no sufficient information sources can be identified for the analysis and subsequent construction of the conceptual framework, the Planning phase (see section A – Planning phase) may have to be revisited to adjust the information domain(s) for which the conceptual framework should be constructed, or else a methodology for conceptual framework construction focusing on unstructured information should rather be considered.

Analysis of relevant information sources

In this activity, the main focus is placed on investigating the content that is contained in each of the identified information sources, as well as the structure (if any) in which the information is stored. An approach that works effectively, particularly in the case of relational databases, is the utilisation of entity relationship diagrams (ERDs, see also section 4.2 and Chen 1976) and data dictionaries (which lists the data terms or entities that exist within the organisation's information sources and the meaning that these terms have for different people in the organisation (Kendall & Kendall 2002)). In most cases ERDs and data dictionaries will already exist for organisational information sources, but where this is not the case, ERDs and data dictionaries (or any other means which will allow a person to understand the internal structure of an information source and the meaning of its terms or entities) will have to be compiled to ensure that an adequate description of the information source is available for use in this and the next phase (see section C – Development phase) of the conceptual framework implementation process.

Besides understanding each of the information sources on its own, it is also essential to acquire an understanding of the manner in which the various information sources relate to one another. It is important to understand the manner in which changes in any information source influence another, and to what extent overlapping and duplication of information exists between the information sources in question. This information plays a crucial role in the generation of a unified view of organisational information, which is to be generated in the Development phase.

Apart from the content, structure and interrelations of the information sources in question, there are two more aspects that should be addressed as part of the preparation for the Development phase, as well as for the Implementation phase (see section D – Implementation phase) of the conceptual framework implementation process. The first is to identify the specific information within the analysed information domain that fulfils the information needs expressed by the stakeholders. The reason for this is, because the analysis and development of a conceptual framework entails the interaction with very large amounts of

information, it can very easily happen that the conceptual framework is implemented without ensuring that the stakeholders' information needs are met. It therefore serves as a control measure which prevents those persons involved in the implementation from straying off course. The second aspect to be addressed is the gathering of information on the typical frequency of change within the information sources in question. This information will become quite important in the Implementation phase of the conceptual framework implementation process, as it will influence how regularly the information contained in the developed conceptual framework have to be updated in order to provide an accurate and current view on the domain in question.

Outputs:

- Information to be included in the **"Conceptual Framework Implementation – Analysis phase"** document (indicated as the output for phase B – Analysis phase). The information required is:
    - The organisational information sources that were identified to provide the source information for the conceptual framework implementation, together with information on the following aspects of these information sources:
        - The content and structure of the information sources;
        - The manner in which the information sources are related;
        - The manner in which the information sources satisfy stake holder information requirements; and
        - The frequency of change in the information sources.

Designation:	**B2**	*Title:*	**Development of conceptual framework specification**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description:

Through this activity, a conceptual framework specification (in the form of a type-relation structure) is created from which the planned conceptual framework will be developed and implemented.

Rationale:

The specification acts as a blueprint of the conceptual framework and is required to ensure that the conceptual framework that is implemented conforms to the needs of the implementation stakeholders.

Prerequisites:

- Information on the structure and content of the information sources in the conceptual framework implementation domain that can sufficiently address the information needs specified by the implementation stakeholders, as well as information on the manner in which these information sources are related (Activity B1)

Execution:

Identify types from information sources

The concept of conceptual framework types (defined in section 5.2.1) is useful for grouping conceptual framework entities that share some similarity. It enables persons interacting with the information in the conceptual framework to locate sought-after information quite rapidly, as it provides them with the ability to locate information by (usually) focusing on certain general characteristics of the information. It also provides a very simple means of creating a conceptual framework from structured information, as such groupings of information normally also exist within this environment. If one considers databases for instance, it should be

quite clear that the field names in a database table typically denote a common characteristic of the values in the database table that are associated with those fields.[22] For conceptual framework development it is necessary to first identify all the types that exist within the information sources for which associated types can be created in the conceptual framework. This identification will typically take place by scrutinising the ERDs and data dictionaries gathered and/or developed during the analysis that was performed on the organisational information sources performed in the first part of the Analysis phase (Activity B1).

To illustrate, consider a database example where a hypothetical database table (shown in Table 6.1) contains miscellaneous employee information.

Table 6.1: Example of utilising database fields as conceptual framework types

Emp_ID	Emp_Name	Emp_Birthdate	Emp_Address_Street	Emp_Address_Number	Emp_Address_Town	Emp_Department_FK
1	Howard Shore	1946/10/18	First Street	24	Ontario	1
2	Peter Jackson	1961/10/31	Valhalla Avenue	13	Pukerua Bay	2

"Howard Shore" and "Peter Jackson" are both associated with the database field **"Emp_Name"**, which obviously denotes that the values are employee names, and that the field stores employee names. A type "Employee" (or "Employee Name") can therefore be created in the conceptual framework, under which the names of all persons in the system can be grouped if they are employees of the organisation. Furthermore, if it is decided that a person in the organisation is signified by his/her name, the type "Employee" could possibly not only represent employee names, but the actual employees themselves[23]. More types that can be identified from the database table in question are **"Emp_Birthdate"**, **"Emp_Address_Street"**, **"Emp_Adress_Number"**, and **"Emp_Address_Town"**. Therefore, if one takes a more general view on the manner in which the information contained in database tables are transferred to the conceptual framework, it can be seen that types are typically identified by placing specific focus on the vertical relations that already exist in the tables (see Figure 6.3).

	Field_1	Field_2	Field_3	…	Field_m
Record_1	Value_11	Value_12	Value_13	…	Value_1m
Record_2	Value_21	Value_22	Value_23	…	Value_2m
Record_3	Value_31	Value_32	Value_33	…	Value_3m
⋮	⋮	⋮	⋮		⋮
Record_n	Value_n1	Value_n2	Value_n3	…	Value_nm

Figure 6.3: Identification of information source types through the vertical investigation of a database table

A special case **"Emp_Department_FK"** (another field of the database table under consideration, Table 6.1)

[22] *This is obviously just one way to identify types in an organisational information domain. Various other techniques can also be applied, for instance, filtering on certain values in database fields, e.g. "Organisation Employees" = all people having "@organisationname" as part of their e-mail address.*

[23] *Such decisions should however be made during the optimisation of the type-relations structure which forms part of the conceptual framework specification (see **Refine type-relation structure**)*

indicates a link between the employee database and a database table containing information on the organisation's departments. In this case the actual values of **"Emp_Department_FK"** are not important, but rather the relation between the values in the two tables, as this will guide those persons performing the analysis in finding the information source that contains specific department information which should be associated with the employee information.

Develop default relations between types

Once the types that exist in the defined information sources have been defined (see previous section) default conceptual framework relations (defined in section 5.2.1) should be defined between these types, as this will provide users with the means to access information through connections already existing within the information sources. These relations will most probably correspond very closely with the manner in which the types are already related in the information source (and will possibly not be very intuitive for some users), but will provide a starting structure through which all information can be accessed by the conceptual framework users. Once the conceptual framework has been implemented and users start to interact with it, they can define their own relations which will enable them to interact with the information in a much more comfortable manner.

Returning to the example discussed in the previous section (focusing on the database table shown in Table 6.1), a relation ***"was born on date"*** may be defined between type **"Emp_Name"** and **"Emp_Birthdate"**, which will yield the conceptual framework fact (defined in section 5.2.1) **"Emp_Name"**-***"was born on date"***-***"Emp_Birthdate"***. Other possible facts that may be defined are:

- **"Emp_Name"**-***"lives in street"***-**"Emp_Address_Street";**
- **"Emp_Name"**-***"lives in town"***-**"Emp_Address_Town"**;
- **"Emp_Name"**-***"works in department"***-**"Dept_Name"** (remember the foreign key example in the previous section); and even
- **"Emp_Birthdate"**-***"is the birthdate of an employee living in town"***- **"Emp_Address_Town"**;

It can be postulated that the number of possible relations that can initially be defined between the different types that were extracted from the organisational information sources is expressible as the square of the number of types, as each entity is potentially related to itself as well as to all the other types that were defined, i.e.

$$\#\text{ of relations} = n^2, \text{where } n = \#\text{ of types}.$$

This is however a misconception, as it presupposes that relations are unidirectional, i.e. A → B ≠ B → A. As this is not the case (i.e. A → B = B → A), the maximum number of possible relations that can initially be defined between the different types that were extracted from the organisational information sources, are

actually expressible as follows:

$$\#\ \text{of relations} = \tfrac{1}{2}(n^2+n), \text{where } n = \#\ \text{of types}.$$

Although the growth in the maximum number of relations is much slower than would have been the case were the number of relations expressed as the square of the number of types (see Figure 6.4), it can be seen that even a moderately sized conceptual framework could contain a very large number of relations, which will have a significant impact on the amount of effort required to create a conceptual framework specification.

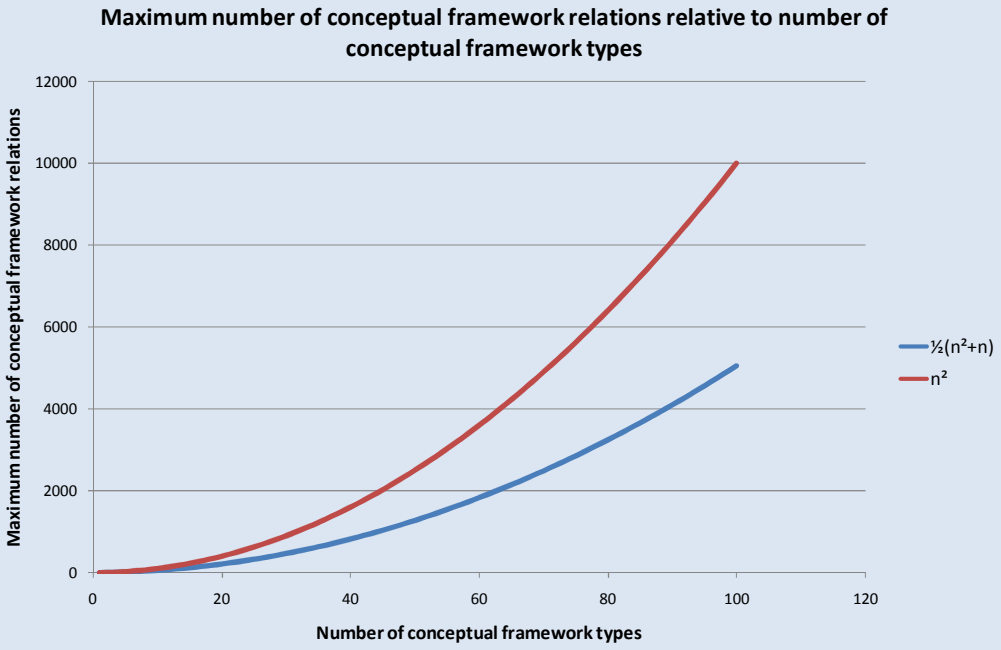


Figure 6.4: Maximum number of conceptual framework relations relative to the number of conceptual framework relations

The number of relations utilised in the conceptual framework can however be reduced through evaluation and subsequent exclusion from the conceptual framework, as some type combinations will exist that fail to represent any useful information (e.g. the relation between the telephone number of an employee and the number of pages printed by one of the organisation's printers). Type-pairs that do not warrant a relation should however be documented, for possible re-evaluation at a later stage. An evaluation approach that proved to be very effective (although unfortunately also very time-consuming) is the listing of all the identified types along the two axes of a matrix, by which every type combination can be evaluated (see Table 6.2).

Table 6.2: Table for evaluating conceptual framework type combinations

	Type_1	Type_2	Type_3	…	Type_n
Type_1	Relation_11	Relation_12	Relation_13	…	Relation_1n
Type_2		Relation_22	Relation_23	…	Relation_2n
Type_3			Relation_33	…	Relation_3n
⋮	⋮	⋮	⋮		⋮
Type_n				…	Relation_nn

Should it however be possible to automate the evaluation process, it will be possible to rapidly reduce the amount of time required to perform the type combination evaluation. The defining of relations between the types of a conceptual framework is a very labour-intensive task, but of the utmost importance to the conceptual framework construction process, as it is essential in providing the users of the conceptual framework with a view on organisational information that is both useful and familiar to them, and with which they can interact with confidence. When one then also takes a more general view on database tables and, in this case, the manner in which information regarding the relations that exist within the database is transferred to the conceptual framework, it can be seen that relations are typically identified by placing specific focus on the horizontal relations that already exist in the tables (see Figure 6.5).

	Field_1	Field_2	Field_3	…	Field_m
Record_1	Value_11	Value_12	Value_13	…	Value_1m
Record_2	Value_21	Value_22	Value_23	…	Value_2m
Record_3	Value_31	Value_32	Value_33	…	Value_3m
⋮	⋮	⋮	⋮		⋮
Record_n	Value_n1	Value_n2	Value_n3	…	Value_nm

Figure 6.5: Identification of information source relations through the horizontal investigation of a database table

Refine type-relation structure

The definition of types and relations from organisational information sources will probably have yielded a number of separate conceptual frameworks, which each represents a specific information source. These conceptual frameworks (and the information contained in them) remain separate from each other, as the overlapping of information contained within organisational information sources has not yet been considered. In order to create a consistent and "whole" conceptual framework which offers users a unified view of the information domain in question, overlapping types must be combined as they essentially represent the same entities within the organisational information domain. To illustrate, consider the following example: After the definition of types within the organisational information sources and relations between these types has been concluded, the organisational conceptual framework presents a fragmented view of the organisational information domain, consisting of three "sub"-frameworks which describe information from three information sources, namely an employee database, a product database and a department database (see Figure 6.6).

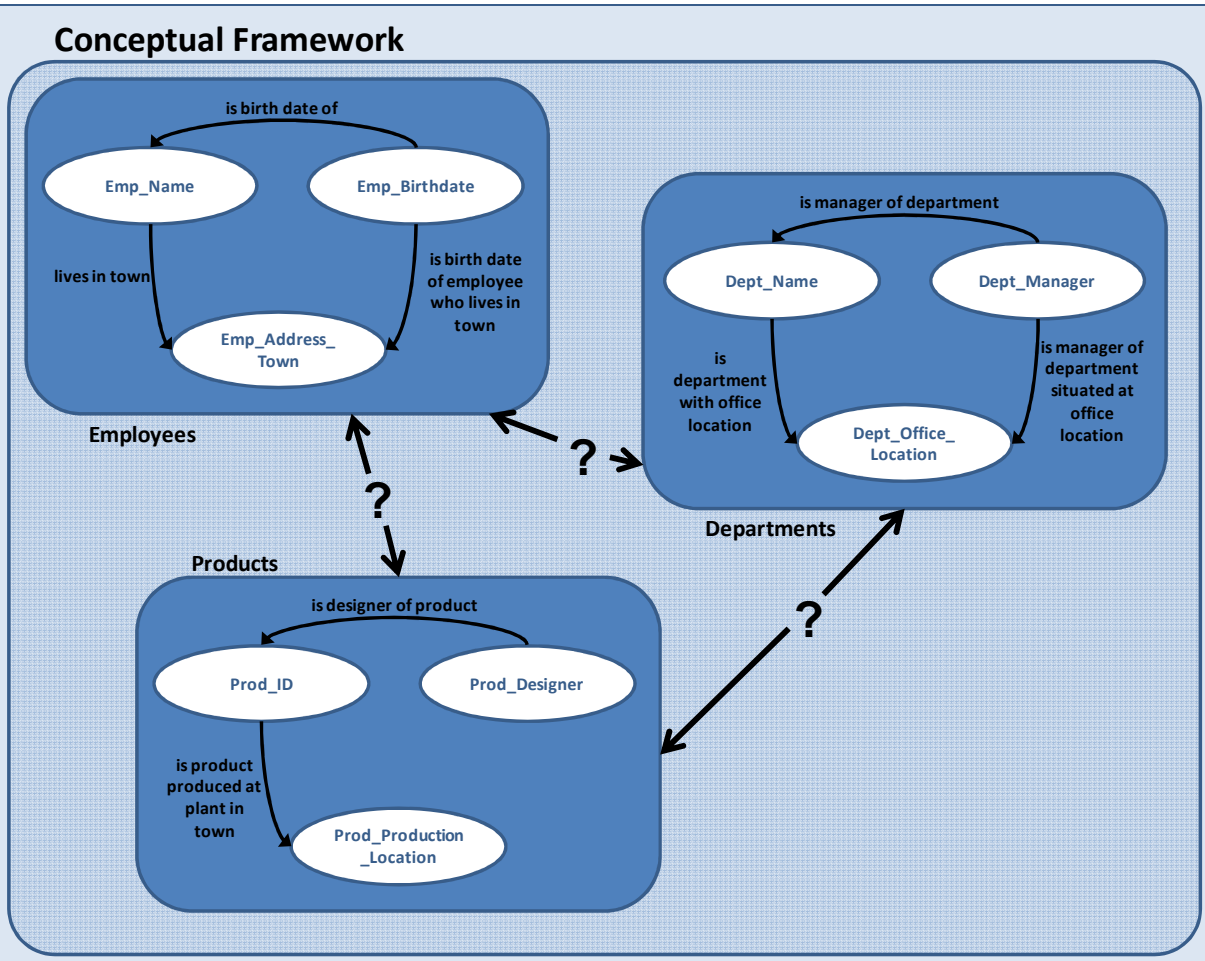


Figure 6.6: Example of a fragmented conceptual framework

It is obvious to see that **"Dept_Manager"** and **"Product_Designer"** are also employees of the organisation, which means that **"Emp_Name"**, **"Dept_Manager"** and **"Product_Designer"** can be combined to form a single type named **"Employee",** or even just **"Person"**. The same can be said of **"Emp_Address_Town"** and **"Prod_Production_Location"**, which may be combined to form a new type named **"Town"**. Once this combining of types has taken place (and some of the types have been given more user-friendly labels), the refined conceptual framework will look as shown by Figure 6.7.

The conceptual framework now provides an integrated view of the information contained in the three information sources discussed. It is, however, important to retain the information on the manner in which the combination of types took place, as this information will be crucial when the conceptual framework is populated in the Development phase of the conceptual framework implementation process (see C – Development phase).

(Note: It may happen that the conceptual framework remains fractured (even after refinement of the type-relation structure has been performed) due to the fact that certain information which is crucial to the conceptual framework implementation do not exist in an explicit manner in any of the organisation's

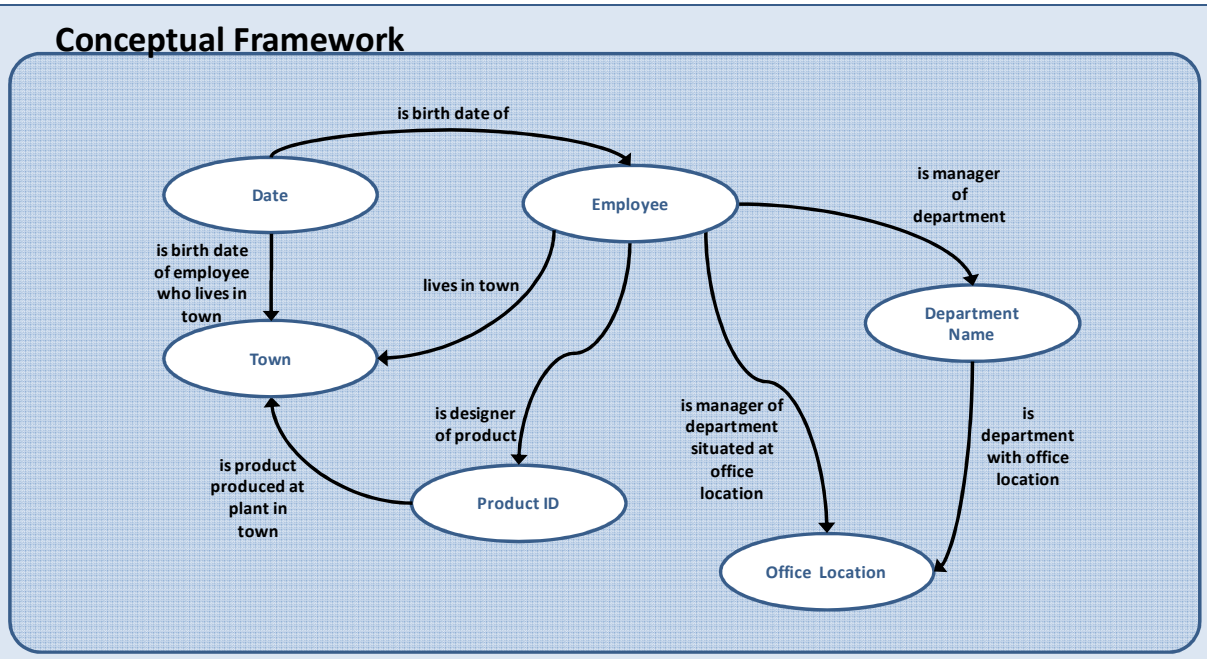


Figure 6.7: Example of a refined conceptual framework

information sources, but exists rather in an implicit form as a shared understanding between a number of the organisation's employees. The capturing of this information in an electronic form will be required in order for the conceptual framework to provide a complete and consistent view of the organisation's information. Once this information has been captured, its types and relations can be identified and also added to the type-relation structure which is developed in this phase of the implementation process.)

Verify type-relation structure

Once the refining of the conceptual framework has been concluded, the type-relation structure that was developed through the Analysis phase should be verified to ensure the correctness of the structure. The verification should take place on the following two levels:

- Information level: Discussions with the database and other information administrators of the information domain in question are required, in order to confirm the following aspects of the conceptual framework type-relation structure:
    - The correctness of the defined conceptual framework types, i.e. do the defined types correctly represent the information that constitutes the specified information domain?
    - The correctness of the defined conceptual framework relations, i.e. do the relations defined between the types correctly represent the manner in which information can be retrieved from the information domain?
    - The correctness of the type refining, i.e. were the information source types grouped together in the correct manner?

If any problems exist with any of these aspects, the relevant aspect should be readdressed, followed by additional verification until all persons involved are satisfied with the result.

- Logical level: Once the database and other information administrators are satisfied with the integrity of the type-relation structure, it should be presented to the stakeholders of the conceptual framework implementation (refer back to the Planning phase, see section A – Planning phase) for confirmation that it satisfies their information requirements (at least conceptually). Again, the three aspects discussed in the previous points should be evaluated (namely the correctness of types, relations and refining), but in this case the focus should be shifted to the perspective of a user of the information and the way in which the information domain under consideration is understood by the stakeholders. Also, because the total extent of the implementation is now known, complete cooperation is required from information infrastructure stakeholders to ensure that the implementation is accomplished as intended.

Once the stakeholders are satisfied that the type-relation structure mirrors their understanding of the types and the relations between them that constitute the specified information domain, the Analysis phase can be considered concluded and the Development phase can commence. Should the type-relation structure fail to satisfy the stakeholders' needs, it could be an indication that the stakeholders' initial information needs were incorrectly identified or that the definition of the type-relation structure was done in an incorrect manner, which would require that the Analysis phase of the conceptual framework implementation process be repeated, or even that the Planning phase of the conceptual framework implementation process be re-conducted.

Outputs:

- Similar to Activity B1, the output of this activity is information to be included in the **"Conceptual Framework Implementation – Analysis phase"** document (indicated as the output for phase B – Analysis phase). The information required is:
    - The conceptual framework types that were identified from the information sources, together with the location of the information represented by these types (preferably down to table-level in the case of a database) and their frequency of change;
    - The relations that were identified between the conceptual framework types; and
    - The final type-relation structure of the conceptual framework after refining, also indicating the manner in which types were grouped together to create an integrated view on the organisational information.

C – Development phase

Designation:	C	*Title:*	**Development Phase**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description:

During the Development phase of the conceptual framework implementation process the actual conceptual framework is created within the organisation, and populated with information extracted from its information sources.

Rationale:

Specific activities are required in order to successfully transform organisational information into conceptual framework format.

Prerequisites:

- Read-access to the relevant organisational information sources, as provided by the information infrastructure stakeholders (Activity B2)
- The organisational conceptual framework specification (refined type-relation structure) (Activity B2)

Execution:

- **Activity C1 – Fulfil conceptual framework hardware requirements**
- **Activity C2 – Create and populate conceptual framework**
- **Activity C3 – Verify information represented by conceptual framework**

Outputs:

- The following information that has been generated through the activities that constitute this phase, should be captured in a **"Conceptual Framework Implementation – Development phase"** document, and will function as a log of the conceptual framework generation, capturing information on the interaction with the organisational information infrastructure in order to generate the organisational conceptual framework:
    - General information on the conceptual framework software tool utilised in the implementation, especially noting its manner of information storage (see Activity C1);
    - The ETL processes (such as SQL queries, etc., associated with their specific information sources) that were developed and utilised in the creation of the conceptual framework (see Activity C2);
    - A declaration by the implementation stakeholders on the implementation, giving sign-off on the conceptual framework that was developed and releasing it for organisation-wide user implementation (see Activity C3).
- A fully functional and stake holder-validated conceptual framework, residing in the organisational conceptual framework software tool (and already part of the organisational information infrastructure).

- ***Activities***

Designation:	**C1**	*Title:*	**Fulfil conceptual framework hardware requirements**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description:

This activity focuses on the acquisition of the hardware on which the organisational conceptual framework (and the software which facilitates user interaction with the conceptual framework) will reside.

Rationale:

The conceptual framework and the software tool which is to facilitate user interaction with the organisational conceptual framework require specific hardware capabilities, which have a direct impact on the performance experienced by users when interacting with the implemented conceptual framework.

Prerequisites:

- Information on hardware capabilities required by the conceptual framework software

Execution:

The organisational conceptual framework will be created and made accessible to users through a conceptual framework software tool, designed to facilitate the interaction between users and conceptual frameworks. The hardware required by this software tool should be acquired to insure that the software tool can effectively provide the functionality required by users interacting with the implemented conceptual framework. With assistance from the information infrastructure stakeholders (see section A – Planning phase), the required equipment should be procured, installed and configured according to the specifications provided by the developers of the conceptual framework software, after which the software itself should be installed and configured in the prescribed manner.

Outputs:

- Information to be included in the **"Conceptual Framework Implementation – Development phase"** document (indicated as an output for phase C – Development phase). The information required is:
    - General information on the conceptual framework software tool utilised in the implementation, especially noting its manner of information storage.
- A fully functional and tested installation of the conceptual framework software tool residing on hardware that is part of the organisation's information infrastructure and is dedicated for conceptual framework purposes.

Designation:	**C2**	*Title:*	**Create and populate conceptual framework**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description:

Through this activity, organisational information is extracted from organisational information sources and, based on certain guidelines and requirements associated with the conceptual framework software tool being used (see Activity C1), and transformed into the organisational conceptual framework as described by the conceptual framework specification developed during the Analysis phase (see B – Analysis phase).

Rationale:

This activity creates the conceptual framework with which organisational users will interact in order to improve the manner in which information is located, viewed and utilised in the organisation.

Prerequisites:

- Read-access to the relevant organisational information sources, as provided by the information infrastructure stakeholders (Activity B2)
- The organisational conceptual framework specification (refined type-relation structure) (Activity B2)
- A fully functional and tested installation of the conceptual framework software tool residing on hardware that is part of the organisation's information infrastructure and is dedicated for conceptual framework purposes (Activity C1)

Execution:

Extraction, transformation and loading of data into conceptual framework

Once the necessary network and information source access have been acquired, the information specified by the type-relation structure developed in the Analysis phase (see section B – Analysis phase) must be extracted from the relevant information sources and transformed by the conceptual framework software tool into the

organisational conceptual framework with which users can interact. This is typically an ETL (Extraction-Transformation-Loading) process (Skoutas & Simitsis 2006) through which information is extracted from an information source, transformed into the storage format used by the conceptual framework software tool (should it be necessary), and then loaded into the storage of the conceptual framework software tool from where the tool will make the information available for user interaction.

The extraction of information from an information source and the subsequent transformation of said information is however not a trivial process, and may be performed in myriad ways, depending mostly on the manner in which information is stored within the specific information source (e.g. as relational database tables, spreadsheets, flat text files, etc), and on the structure in which the conceptual framework software tool requires the information to be stored in order to effectively interact with it (similar to Skoutas & Simitsis 2006). The success of this activity within the Development phase (see section C – Development phase) therefore depends on an exact understanding of the differences between the manner in which information is stored within the various information sources of the implementation domain, and the manner in which the conceptual framework software tool requires the information to be stored. For example, if an information source and the conceptual framework software tool both make use of relational databases for the storage of information, simple SQL (Structured Query Language) querying and other operations should be sufficiently able to extract, transform and store data in the format required by the conceptual framework software tool. Should the information source be a spreadsheet, the extraction, transformation and loading of the data should also be quite straightforward. In the event that the conceptual framework software tool utilises text-base data storage like XML (Extensible Markup Language) however, a SQL query output from a database will obviously have to undergo more complicated transformations in order to conform to the particular storage method.

Based on an understanding of the different manners in which information may be extracted from the organisational information sources, the conceptual framework should be constructed in an incremental fashion through the executing of the various associated ELT processes, which are customised to extract data from each of the conceptual framework implementation domain's information sources and provide it to the conceptual framework software tool in the required manner. Utilising this information, the conceptual framework software tool can now present the content of the information domain to the user and, through its various functionalities, provide the user with the means for navigation of the information, interaction with the information and information discovery.

Verification of conceptual framework rationality

To conclude the activity of creating and populating the organisational conceptual framework, verification of the rationality of the conceptual framework is required. This is purely a measure of control to ensure that the rationality contained in the conceptual framework specification was correctly transferred to the actual conceptual framework, and that the information that is presented by the conceptual framework makes sense. This is a simple exercise and should not require more effort than the evaluation of a few facts associated with

each relation between the various conceptual framework types. If nonsensical relations are found, the ETL process that generated the information should be investigated and corrected if found to be faulty. If the specific ETL process executed correctly, and the specification of the conceptual framework were actually found to be at fault (which means that the specific relation should therefore not exist within the conceptual framework), it should be corrected, and the relevant ETL processes be updated to reflect the change. Following any corrections, the conceptual framework should obviously be regenerated.

Outputs:

- Information to be included in the **"Conceptual Framework Implementation – Development phase"** document (indicated as an output for phase C – Development phase). The information required is:
    - The ETL processes (such as SQL queries, etc., associated with their specific information sources) which were developed and utilised in the creation of the conceptual framework.
- A fully functional and rationality-verified conceptual framework, residing in the organisational conceptual framework software tool (and already part of the organisational information infrastructure).

Designation:	**C3**	*Title:*	**Verify information represented by conceptual framework**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description:

At this stage, an operational conceptual framework has been developed with which users can interact for various information locating-type activities. To complete the Development phase of the conceptual framework implementation process, the implementation stakeholders should verify the correctness of the information represented by the conceptual framework, and determine whether the information and views represented by the conceptual framework conform to the requirements stipulated by them in the Planning phase.

Rationale:

This activity is aimed at ensuring that the conceptual framework that was created conforms to the requirements of the implementation stakeholders, as well as to their understanding of the organisation.

Prerequisites:

- A fully functional and rationality-verified conceptual framework, residing in the organisational conceptual framework software tool (and already part of the organisational information infrastructure) (Activity C2)

Execution:

Each of the stakeholders will be required to spend some time evaluating the conceptual framework and the information it contains. The duration of this evaluation should be determined by the stakeholders as a group, and will typically be proportionate to the magnitude and the complexity of the implementation domain. Should any problems be unearthed during this evaluation, the sources of these problems (which most probably would have occurred in one or both of the Analysis or Development phases) should be determined, and addressed. Once satisfied, the stakeholders should give sign-off on the conceptual framework, which will

act as validation for the conceptual framework and release it for organisation-wide user implementation.

Outputs:

- Information to be included in the **"Conceptual Framework Implementation – Development phase"** document (indicated as an output for phase C – Development phase). The information required is:
    - A declaration by the implementation stakeholders on the implementation, giving sign-off on the conceptual framework that was developed and releasing it for organisation-wide user implementation.
- A fully functional and stake holder-validated conceptual framework, residing in the organisational conceptual framework software tool (and already part of the organisational information infrastructure).

D – Implementation phase

Designation:	**D**	*Title:*	**Implementation Phase**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description:

Once a conceptual framework has been created and validated by its stakeholders, it should be configured and made available for organisation-wide use.

Rationale:

Up until this point in the implementation, access to the conceptual framework has been limited to those persons involved in the design and development of the conceptual framework. As the conceptual framework can benefit all knowledge workers in an organisation, it should now be made available to more persons within the organisation. This necessitates the reconfiguring of some aspects of the organisational information infrastructure in order to be able to support a changed flow of information because of an increase in user interaction with the conceptual framework.

Prerequisites:

- A fully functional and stake holder-validated conceptual framework, residing in the organisational conceptual framework software tool (and already part of the organisational information infrastructure) (Activity C3)

Execution:

- **Activity D1 – Information infrastructure setup**
- **Activity D2 – User setup**

Outputs:

- In order to preserve the context in which the Implementation phase of the conceptual framework implementation process took place, the following information should be captured in a **"Conceptual Framework Implementation – Implementation phase"** document:
    - The exact arrangements that were made with regards to the information infrastructure for the optimal functioning of the conceptual framework within the organisation, e.g. bandwidth allocation, the updating frequency of information, security, etc. (Activity D1)
    - The initial user base, with associated user account details and security privileges (Activity D2); and
    - The documentation used in the training of the conceptual framework users (Activity D2).
- A final **"Conceptual Framework Implementation"** document should be compiled by combining the four output documents listed below that were created through the course of the conceptual framework implementation process, namely:
    - The "Conceptual Framework Implementation – Planning phase" document;
    - The "Conceptual Framework Implementation – Analysis phase" document;
    - The "Conceptual Framework Implementation – Development phase" document; and
    - The "Conceptual Framework Implementation – Implementation phase" document.

  This document can function as the sign-off document for the conceptual framework implementation, as it contains all the main actions, decisions and designs that contributed to the implementation of the organisational conceptual framework.
- A fully functional operational conceptual framework available to knowledge workers for improved locating, viewing and utilising of organisational information, residing on organisational information infrastructure configured for optimal conceptual framework user interaction.
- Trained users for the organisational conceptual framework

- ***Activities***

Designation:	**D1**	*Title:*	**Information infrastructure setup**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description:

This activity entails the reconfiguring of various aspects of the organisational infrastructure because of changes in the flow of information within the organisation, resulting from the use of the conceptual framework by the organisation's employees.

Rationale:

This activity is performed to ensure that the benefit experienced through the use of the conceptual framework is maximised.

Prerequisites:

- A fully functional and stake holder-validated conceptual framework, residing in the organisational conceptual framework software tool (and already part of the organisational information infrastructure) (Activity C3).

Execution:

Relevant information infrastructure administrators and other decision makers should be approached and a strategy developed through which (at least) the following aspects are addressed:

- Bandwidth allocation: This aspect has a great impact on the overall efficiency of the organisational infrastructure and on the productivity of conceptual framework users. A large allocation of bandwidth to the conceptual framework implementation and its users will ensure fast response times for the software tool being used, but could have a detrimental effect on the other systems and the users of

these systems in the organisation. On the other hand, allocating too little bandwidth to the conceptual framework could obviously result in a negative experience by users of the software tool. It is therefore important to find a balance where as much bandwidth as can be spared be allocated to the use of the conceptual framework, whilst otherwise managing the expectations that users of the software tool will have.

- Updating of information: The organisational conceptual framework will be most useful if it could present a real-time view on the information domain it describes. Implementation stakeholders, as well as other relevant information infrastructure stakeholders and decision makers in the organisation should therefore be tasked to make a decision on the extent of relevancy that is expected of the conceptual framework. With this decision in mind, the various frequencies of change experienced within the information domain (as documented in the "Conceptual Framework Implementation – Analysis phase" document) must be inspected, leading to the creation of a conceptual framework update schedule, which specifies the frequency at which the various ETL processes used in the Implementation phase should be re-run in order to keep the conceptual framework updated (in any case to the extent that the stakeholders require). After the schedule has been compiled, the ETL processes should be configured to execute at the specified time intervals, based on the recommendation set out in the conceptual framework update schedule.
- Security: Within an organisation there are normally certain restrictions in place with regards to information access which is aimed at preventing the potential misuse of organisational information. These restrictions are usually structured around teams or departments and the roles of employees within that teams or departments. For the conceptual framework to be accepted as a tool for organisational use, it is crucial that security considerations also be taken into account and that the information residing in the conceptual framework has the same level of protection as the information residing in the organisational information sources. It would be ideal if the conceptual framework software tool has the capability to integrate with the security mechanisms already resident in the organisation's information infrastructure, as the existing permissions and restrictions associated with the organisational information can then be utilised by the software tool in managing access to specific pieces of information within the conceptual framework (i.e. acting as a layer on top of the conceptual framework which only allows user access based on existing organisational security settings). If the conceptual framework software tool does not offer that functionality, security information that forms part of the implementation domain's information sources should be identified and incorporated into the conceptual framework during the Development phase. The software tool should then be configured to interrogate the conceptual framework itself for security information, which it will then be utilised in managing access to specific information in the organisational conceptual framework.

Bandwidth allocation, updating of information and security are some of the more typical system aspects that will have to be addressed during the implementation of a conceptual framework in an organisation. This is

however by no means an exhaustive list and attention to other system aspects may be necessary, depending on the manner and extent of the conceptual framework implementation and its role in the organisation.

Outputs:

- Information to be included in the **"Conceptual Framework Implementation – Implementation phase"** document (indicated as an output for phase D – Implementation phase). The information required is:
    - The exact arrangements that were made with regards to the information infrastructure for the optimal functioning of the conceptual framework within the organisation, e.g. bandwidth allocation, the updating frequency of information, security, etc.
- A fully functional operational conceptual framework available to knowledge workers for improved locating, viewing and utilising of organisational information, residing on organisational information infrastructure configured for optimal conceptual framework user interaction.

Designation:	**D2**	*Title:*	**User setup**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description:

This activity entails the creation of user accounts through which organisation employees can access the information contained in the conceptual framework, as well as training of these employees in its use.

Rationale:

Controlled access to the information contained in the organisational conceptual framework is required in order to prevent the unsolicited viewing of sensitive information. User training is required as the approach of viewing information as a collection of entities and the relations between them are in its infancy, and not well known to most organisational employees.

Prerequisites:

- A fully functional and stake holder-validated conceptual framework, residing in the organisational conceptual framework software tool (and already part of the organisational information infrastructure) (Activity C3)
- Organisational information infrastructure configured for optimal conceptual framework user interaction (Activity D1)

Execution:

When the relevant information infrastructure aspects of the Implementation phase have been concluded and the conceptual framework is sufficiently configured for use in the organisation (see Activity D1), the user component should be introduced by performing the following activities:

- Creation of user accounts and allocation of security privileges: User accounts should be created in the conceptual framework software tool through which the persons in the organisation that have been

identified as users of the conceptual framework could gain access and utilise the information it contains. Each user account will obviously fit into the conceptual framework's security structures (configured in the information infrastructure setup which was discussed in the previous section), ensuring its associated user has access to the information that pertains to him/her and is prevented from interacting with restricted information. In the spirit of allowing users to perform information discovery through interaction with the conceptual framework (which may lead to the generation of new ideas, the improvement of business processes, etc.), it is however advised that those persons who manage user access to information within the organisational conceptual framework refrain from enforcing too many access restrictions on a user and only prevent user interaction with specific information if absolutely crucial.

- Training: Once the conceptual framework user accounts have been set up, training should be provided to these users, imparting both the theoretical and practical knowledge that they will require to interact with the organisational conceptual framework in the most beneficial manner. The theoretical component of the conceptual framework user training should explain the conceptual framework approach in general, the manner in which it utilises entities and relations to create a navigable structure for information gathering and discovery, as well as the ways in which the organisation (and the users themselves) will benefit from interaction with the conceptual framework. The practical component should focus on familiarising the users with the various features and functionalities offered by the specific conceptual framework software tool employed by the organisation (hands-on, if possible), and how it allows them to interact with the conceptual framework. A final understanding which should be impressed on the users of the conceptual framework is that it does not only serve as a mechanism for finding information; it enables them to integrate their own knowledge into the greater whole of the organisational knowledge and by interacting and contributing to the conceptual framework on a regular basis, they themselves (as well as the organisation as a whole) will benefit.
- Launch: Finally, to conclude the Implementation phase and to initiate organisation-wide use of the conceptual framework, relevant communiqués should be distributed within the organisation, announcing the commencement of use of the conceptual framework, its purpose and its intended value to the organisation.

Outputs:

- Information to be included in the **"Conceptual Framework Implementation – Implementation phase"** document (indicated as an output for phase D – Implementation phase). The information required is:
  - The initial user base, with associated user account details and security privileges; and
  - The documentation used in the training of the conceptual framework users.
- Trained users for the organisational conceptual framework.

E – Maintenance phase

Designation:	**E / E1**	*Title:*	**Maintenance Phase / Grow Conceptual Framework**

Navigation:

A - Planning	B - Analysis	C - Development	D - Implementation	E - Maintenance
A1 – Identify stakeholders	B1 – Examination of information sources pertaining to stakeholder-specified information requirements	C1 – Fulfil conceptual framework hardware requirements	D1 – Information infrastructure setup	E1 – Grow conceptual framework
A2 – Initial information need identification	B2 – Development of conceptual framework specification	C2 – Create and populate conceptual framework	D2 – User setup	
		C3 – Verify information represented by conceptual framework		

Description and Rationale:

A conceptual framework implementation typically focuses only on a subset of organisational information, delivering a conceptual framework that only describes the information found within a specific information domain within the organisation. In order to represent the organisation's information in its entirety, more iterations of the conceptual framework implementation process should therefore be performed. Such iterations can vary in magnitude and scope, being (for example) the correction of user-identified errors that occurred during the creation of the conceptual framework in the Development phase of an implementation, the adding of entities or relations that were excluded or overlooked in the design of the conceptual framework during the Analysis phase, or even another full implementation with (possibly) new stakeholders and new information requirements (which means adding the information of an entirely new domain to the existing conceptual framework). It is however imperative that, irrespective of the extent of such iteration, any changes to the organisational conceptual framework be captured in the relevant documentation as specified in this methodology, in order to retain the knowledge that was acquired on the process that was followed, as this could be beneficial in future conceptual framework maintenance efforts.

Finally: It is important that the conceptual framework is continuously grown through the execution and re-execution of the conceptual framework implementation process, as this will eventually yield a conceptual framework which can provide users with access to and a view on all the information that an organisation possesses, enabling them to interact with and utilise organisational information in an efficient manner.

Prerequisites:
• An existing conceptual framework
Execution:
• See *Description and Rationale* above
Outputs:
• Improved/expanded organisational conceptual framework

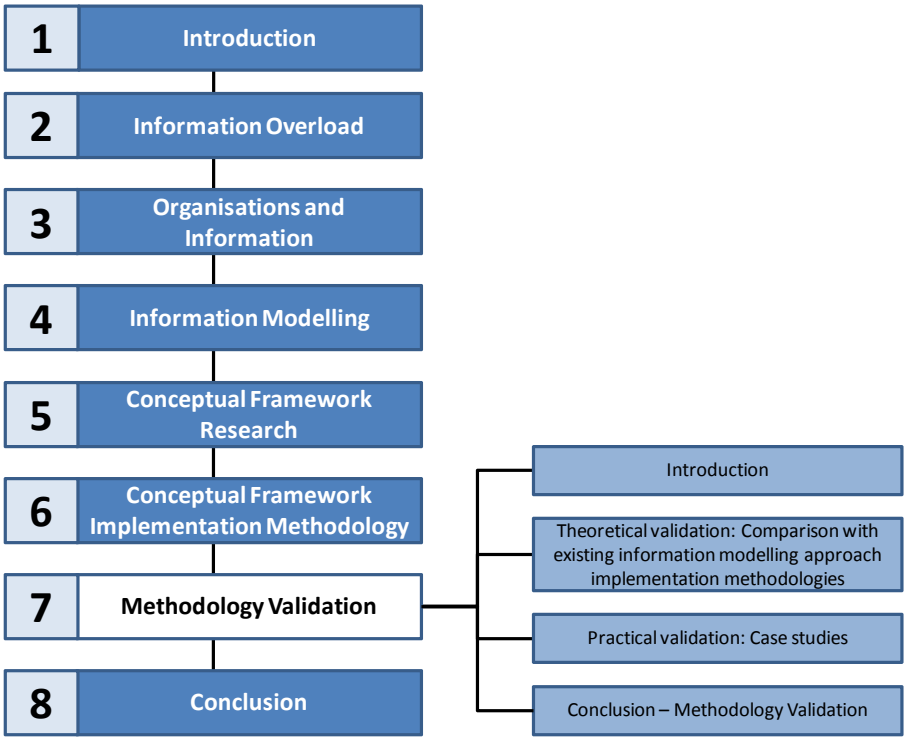


Figure 7.1: Image for navigating thesis and chapter 7

7.2 *Theoretical validation: Comparison with existing information modelling approach implementation methodologies*

Subsequent to the development of the methodology introduced in the previous chapter (Chapter 6), a brief investigation was performed through which a number of existing information modelling approach implementation methodologies were identified and compared to the conceptual framework implementation methodology for validation purposes. The focus and level of detail of the methodologies used for the comparison varies, but the collection of methodologies was deemed sufficient for validation of the conceptual framework implementation methodology. For the purpose of this discussion the methodologies investigated were divided into those that focus on the same level of detail as the conceptual framework implementation methodology, and those that do not.

- Rationalize (Data Semantics) - Capture the meaning of data by mapping to the Information Model.
- Publish/Deploy - Share the Information Model, metadata and semantics with relevant stakeholders; customise it to their specialized needs.
- Utilize - Create processes to ensure utilisation of architecture in achieving data management, data integration and data quality.

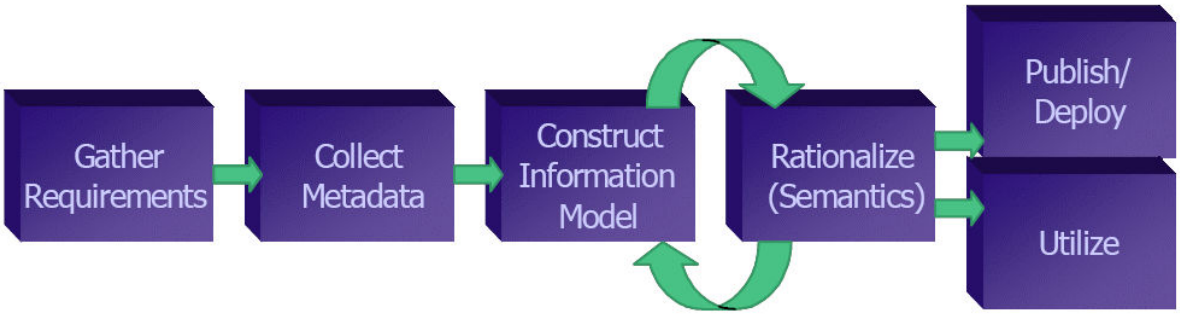


Figure 7.2: The Semantic Information Management methodology (Source: Schreiber 2003)

• *The Knowledge Lens methodology*

The Knowledge Lens methodology (Edgington, et al. 2004) was employed in a domain ontology development project at the Intel Corporation in the United States, in which a number of US academic institutions were also involved. The project arose from a need to better utilise past information in performing failure analysis and failure identification (FA/FI) on integrated chips at the large semiconductor manufacturing firm. A hybrid (top-down and bottom-up) modelling approach was used to develop a specific ontology as an enabler to integrating knowledge management practices and processes (Edgington, et al. 2004).

The aim of the project was the establishment of a "Knowledge Lens", which is an ontological focus on organisational knowledge units. 'A knowledge unit is a coarse set of information elements bound together by structure, assumptions, justifications, and process. These characteristics provide a perspective that typically does not exist with mere information or data elements' (Edgington, et al. 2004). The purpose of the Knowledge Lens was to assist the organisation in appropriately calibrating the coordination of its activities for countering innovation aggressiveness from competition, and provide a shared vocabulary, access and reuse, speed and relevancy, and definition of any knowledge unit.

The steps that were followed (and through which the ontology was implemented) are as follows (Edgington, et al. 2004) (see also Table 7.1):

Table 7.1: The iterative ontology development process utilised in the development of Knowledge Lens (Source: Edgington et al. 2004)

Processes	Tasks
Design	Formulate problem statement Define scope Audience/users, goals, resources, schedule, level of formality Develop success and acceptance criteria Investigate tasks and business area goals Analyze use cases
Develop	Extract control vocabulary Develop conceptual model(s) Incorporate vocabulary acquisition tools as appropriate
Integrate	Develop formal interview structure Review models with participants Initiate formal interviews and incorporate into models Expand models with expanded attributes and axioms Develop computational representation as appropriate RDF, XML, formal logic and/or other programmatic representation
Validate and feedback	
Iterate process	Analyze and refine after each process

- Design - The process of design includes formulating the problem statement, defining the project scope, developing success and acceptance criteria, investigating tasks and business area goals, and analysing use cases.
- Develop - Ontological development identifies and extracts the control vocabulary and, by incorporating relevant relationships, develops a number of conceptual models.
- Integrate – Ontology integration starts with the integration of each individual's "knowledge lens" or perspective, and expanding this to the organisation or inter-organisation in conformance with the project's scope. From this integrated model a computational representation is created. Additional extensions to the model in the form of attribute expansion and rules are also added to enrich the contents of the ontology. Any revisions are repeatedly reviewed with participants
- Validate and feedback – Validation of the ontology takes place in three phases: First, the sub-models are validated qualitatively among the participating users and among additional users as adequately representative of the project's focus. Secondly, the ontology is validated by applying the models within constructed queries and manually examined to see how the ontology subsumed the query. Finally, the project champion has face-to-face interaction with the various groups and locations for which the ontology and ontological process were deemed to have value, through which questions from the individual groups can be addressed, support for the approach solicited, and the management value of the approach be high-lighted.
- Iterate process - Iteration should be occurring within most, if not all, of the process steps as interviews and investigations reveal opportunities for improvement and clarity. Analysis of

to implement this information modelling approach. The On-To-Knowledge methodology consists of the following steps (or phases) (see also Figure 7.3):

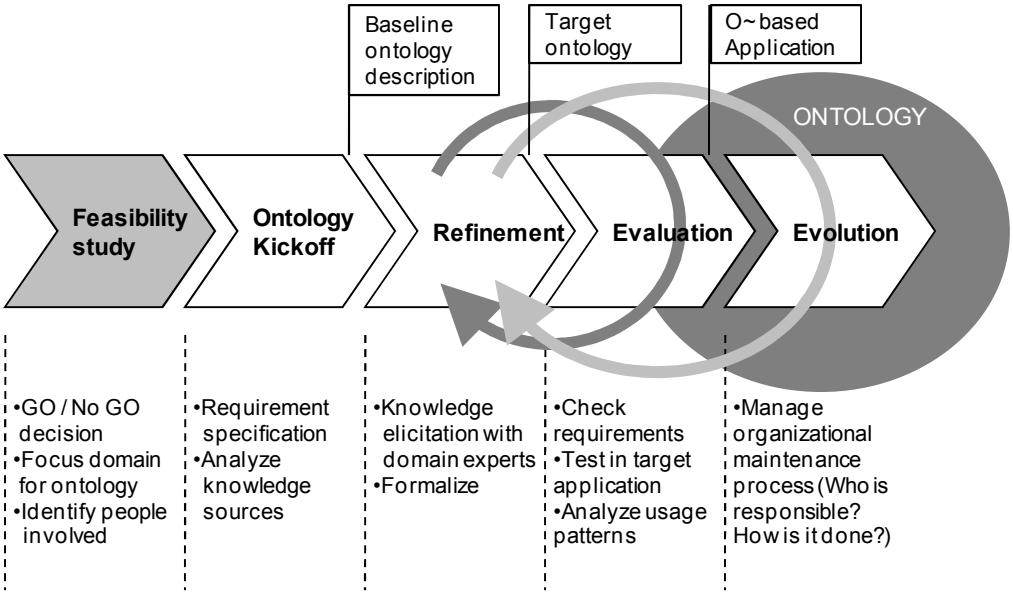


Figure 7.3: The steps of the On-To-Knowledge methodology (Source: Lau & Sure 2002)

- Feasibility study – A feasibility study is performed initially to first, identify problem/opportunity areas and potential solutions, and second, to put these in a larger perspective. By providing information on economical and technical feasibility, it serves as a decision support in order to select the most promising focus area, i.e. the domain for the ontology based system to be developed. Besides the implementation domain of the system it also helps to identify the people involved in setting up and using the system (i.e. the domain experts, users and supporters of the system).

- Ontology kickoff – The requirements of the ontology to be implemented should be captured in an Ontology Requirements Specification Document (ORSD), which describes what the ontology should support, and its area of application. It should guide an ontology engineer to decide about inclusion, exclusion and the hierarchical structure of concepts in the ontology. A "baseline ontology" is gathered through the analysis of available knowledge sources. This ontology typically contains only the most important concepts and relations that have been identified on an informal level.

- Refinement – The purpose of this phase is to produce a mature and application-oriented "target ontology" according to the specification given by the kick-off phase. This phase is divided into the following different sub-phases:

    - A knowledge elicitation process with domain experts based on the initial input from the kick-off phase. This serves as input for further expansion of the baseline ontology. Typically axioms are identified and modelled in this phase.

- Analysis, which addresses the manner in which the organisational structure is analysed in order to ascertain the potential for optimisation
- Optimisation, which addresses the manner in which the structure of the organisation should be optimised
- Implementation, which addresses the manner in which the optimisation is implemented in the organisation

The action fields (together with their subunits) which play a role in each of the implementation phases are as follows:

- Context, which addresses Processes, Roles, Ontologies, and Search classification
- Content, which addresses Documents, and Information sources
- Information technology, which addresses User-interface, Reporting/System analysis, Software environment, Hardware environment, and Support
- Project control, which addresses Enterprise strategy, Change management, Training, Project management, and Cost consideration

A visual representation of the PreBIS implementation (focusing on the 'Context' action field) can be seen in Figure 7.4.

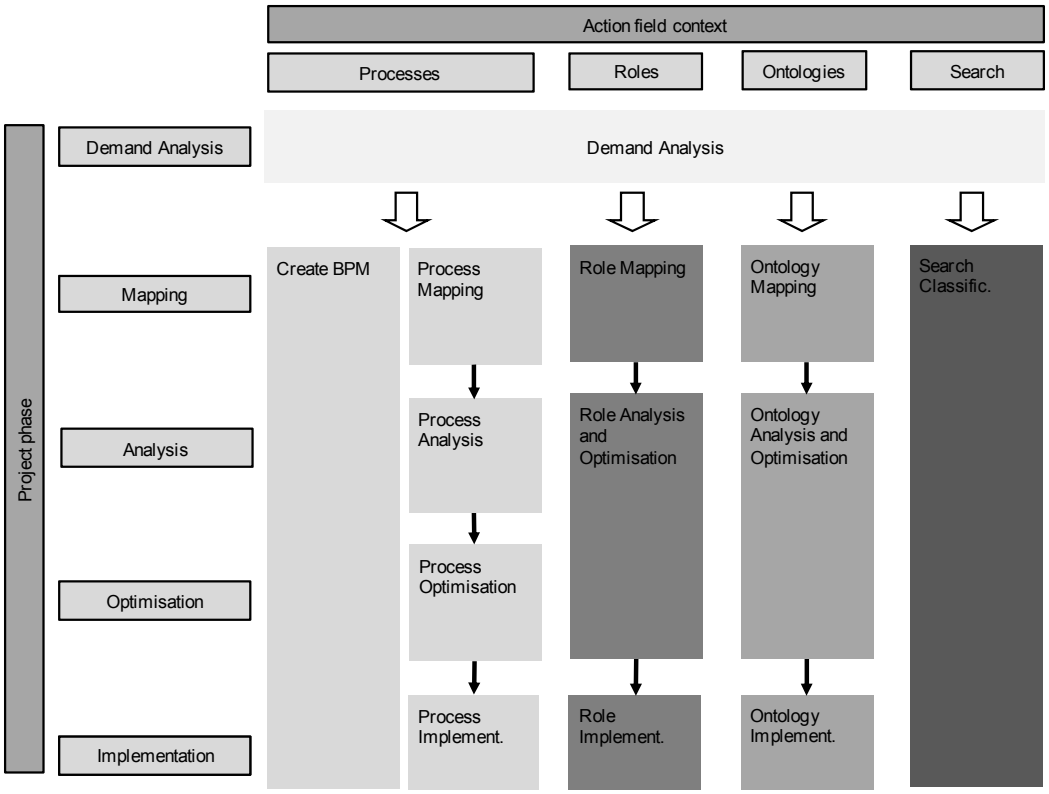


Figure 7.4: Service modules in the 'Context' action field (Source Böhm et al. 2005)

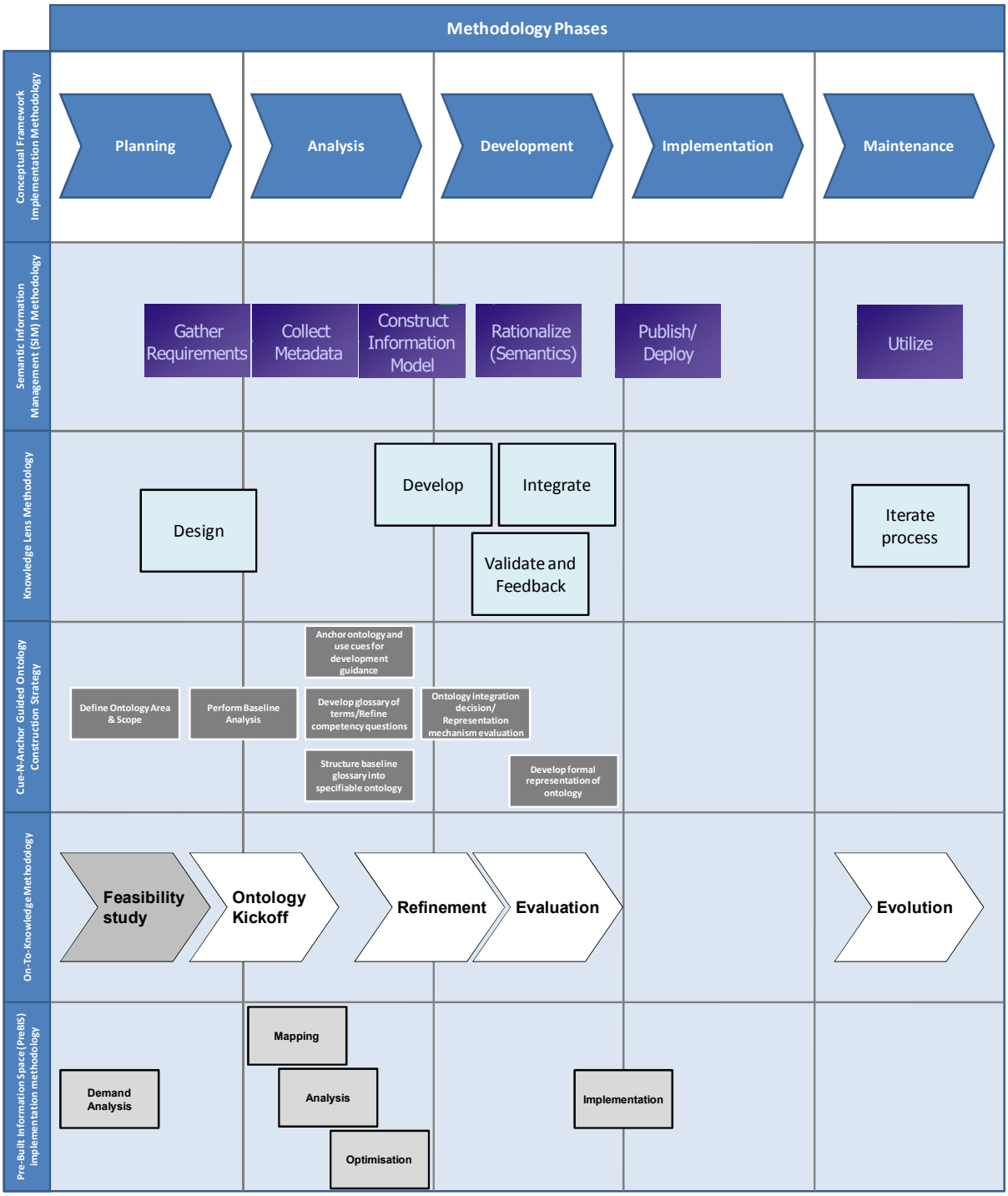


Figure 7.5: Comparison of conceptual framework implementation methodology with other similar information modelling approach implementation methodologies

The methodology phase comparison clearly indicates that, although there is a clear overlapping between the phases of the conceptual framework implementation methodology and the phases of the other methodologies, the manner in which the phases of the other methodologies have been defined prevents the overlapping from being very exact. When one however increases the level of detail when comparing the methodologies, and compare the required activities of each of these methodologies (see section 7.2.1) with those proposed by the conceptual framework implementation methodology, a

significant improvement in the overlapping will be observed. Table 7.2 shows that the activities of the other methodologies can very easily be restructured according to the phase-structure of the conceptual framework implementation methodology, and therefore largely address the same issues as the activities of the conceptual framework implementation methodology (except for the cases where some of the methodologies do not provide guidance regarding post-development and post-implementation strategies).

Table 7.2: Overlapping of activities from other information modelling approach implementation methodologies with the phases of the conceptual framework implementation methodology.

Information Modelling Approach	Conceptual Framework Implementation Methodology				
	Planning	Analysis	Development	Implementation	Maintenance
Semantic Information Management (SIM) Methodology	Yes	Yes	Yes	Yes	Yes
Knowledge Lens Methodology	Yes	Yes	Yes	*No*	Yes
Cue-N-Anchor Guided Ontology Construction Strategy	Yes	Yes	Yes	*No*	*No*
On-To-Knowledge Methodology	Yes	Yes	Yes	*No*	Yes
Pre-build Information Space (PreBIS) Implementation Methodology	Yes	Yes	Yes	Yes	*No*

The fact that the conceptual framework implementation methodology in general addresses the same issues as the other information modelling approach implementation methodologies discussed in this section, indicates that the reasoning behind it is conceptually sound, and that it compares well with tried-and-tested methods for implementing information modelling approaches in organisations. The methodology is thus deemed valid from a theoretical viewpoint.

An aspect of the conceptual framework implementation methodology which warrants special mention, however, is the fact that it places a specific focus on the deployment of the conceptual framework in the organisation with regards to information infrastructure configuration and the users of the approach – something that most of the other methodologies fail to do. These aspects were deemed crucial for the creation of an environment within the organisation that is conducive to the effective interaction with an organisational conceptual framework. It would therefore seem that the conceptual framework implementation methodology is, in this respect at least, more complete than the other methodologies that were used in the comparison. It does not, however, influence the validity of the methodology, and the conceptual framework implementation methodology therefore remains valid (from a theoretical point of view).

7.3.2 Case study: Indutech (Pty) Ltd.

Indutech is a medium-sized industrial engineering company situated in Stellenbosch, South Africa which focuses on providing consulting services and solutions for enhancing client company projects through the incorporation of programme management, knowledge management and innovation management principles into the project processes. The company's core offering is in the form of methodologies and tools that assists its business engineers in enabling companies to perform Company Wide Innovation Management (What We Offer 2008).

Indutech was selected as the site for the first case study to test the conceptual framework implementation methodology as it was already heavily involved in conceptual framework research, and provided a benign testing environment where the worst of the methodology's creases could be smoothed out. Organon, a software tool for the creation, visual navigation and updating of conceptual frameworks, was also developed by Indutech, and was used in both of the case studies that are discussed in this chapter.

Because of the fact that this was the first utilisation of the developed conceptual framework implementation methodology, the conceptual framework that was constructed was quite small in size and was not based on very complex information requirements. The choice to first perform a smaller implementation was made purely to corroborate the relevancy of the aspects addressed by the methodology, and to easily correct any major issues that have not been foreseen during the development of the methodology.

- ***The implementation process***

The implementation process will be discussed in terms of the five phases of the conceptual framework implementation methodology.

Planning

Identify stakeholders

The first activities in the conceptual framework implementation methodology centre around the identification of stakeholders who will take part in the implementation. With the Indutech case study, the manager of Indutech's Integration Services and Support (ISS) department was identified and instated as the project champion and main stakeholder of the implementation (both in the managerial and information infrastructure sense), because of the following reasons:

- He was already heavily involved with conceptual framework research and therefore had an adequate understanding of the purpose of the implementation;
- He had a very good knowledge of the information landscape within the organisation; and
- He managed the department responsible for all information infrastructure administration of the organisation and therefore had the authority to allow access to any of the information sources that Indutech possess.

Initial information need identification

The domain of information within the organisation on which the implementation was to focus, was information on employee activity at Indutech, and the project champion requested information to be provided that was centred around answering the following questions:

- At what time do employees arrive at Indutech?
- Which documents have been worked on by employees on a particular day?
- What projects have been worked on by employees?
- What is the amount of time spent by employees working on a specific project?

It can therefore be seen that the information requirements provided have been stated in a fashion which allows sufficient flexibility in terms of the information that could be included in the conceptual framework. No grouping of information requirements were necessary, because of the small number of requirements provided.

With all activities that form part of the Planning phase concluded, the Analysis phase was undertaken.

Analysis

Examination of information sources pertaining to stakeholder-specified information requirements

With the assistance of the project champion, various information sources in Indutech that could sufficiently address the stated information requirements were identified, and access to these information sources obtained. These information sources were the following:

Development of conceptual framework specification

From the analysis that took place earlier in this phase of the conceptual framework implementation methodology, fourteen (14) conceptual framework types were identified. These types, together with their descriptions, can be seen in Table 7.3.

Table 7.3: Names and descriptions of conceptual framework types identified in Indutech conceptual framework implementation case study

Type Name	Type Description
Client	Companies that are clients of Indutech
Date	Any dates that exist in Indutech information sources
Department	Departments of Indutech
Document	Documents that reside in EDEN™ databases
EDEN	Denoting the names of specific Indutech EDEN™ databases
EDENRights	User access rights with regards to documents found in EDEN™ databases (e.g. Read, Write, Delete, etc.)
EDENRole	Different groups of users in EDEN™ databases (e.g. Administrators, Consulting, Management, etc.)
E-mail	E-mail addresses of Indutech employees
Keyword	Keywords used by Indutech employees for describing documents in EDEN™ databases
Person	Indutech employees
Project	Projects conducted by Indutech internally or for client companies
Project_Role	Roles of Indutech employees in projects
Time	Any time-stamps that exist in Indutech information sources
Work_Duration	The amount of time spent by Indutech employees on projects

A total of forty-four (44) relations were defined between the types, by employing the matrix approach mentioned in section A – Planning phase. This is a great deal less than the $\frac{1}{2}(n^2+n) = \frac{1}{2}(14^2+14) = 105$ potential relations predicted by the conceptual framework implementation methodology, and makes for a very usable framework for interacting with the information. A type-relation structure was created and refined at the same time, resulting in the structure shown in Figure 7.6. The diagram however shows different relations for both A→B and B→A (with A and B being types and → being the relation between them). This does not insinuate that

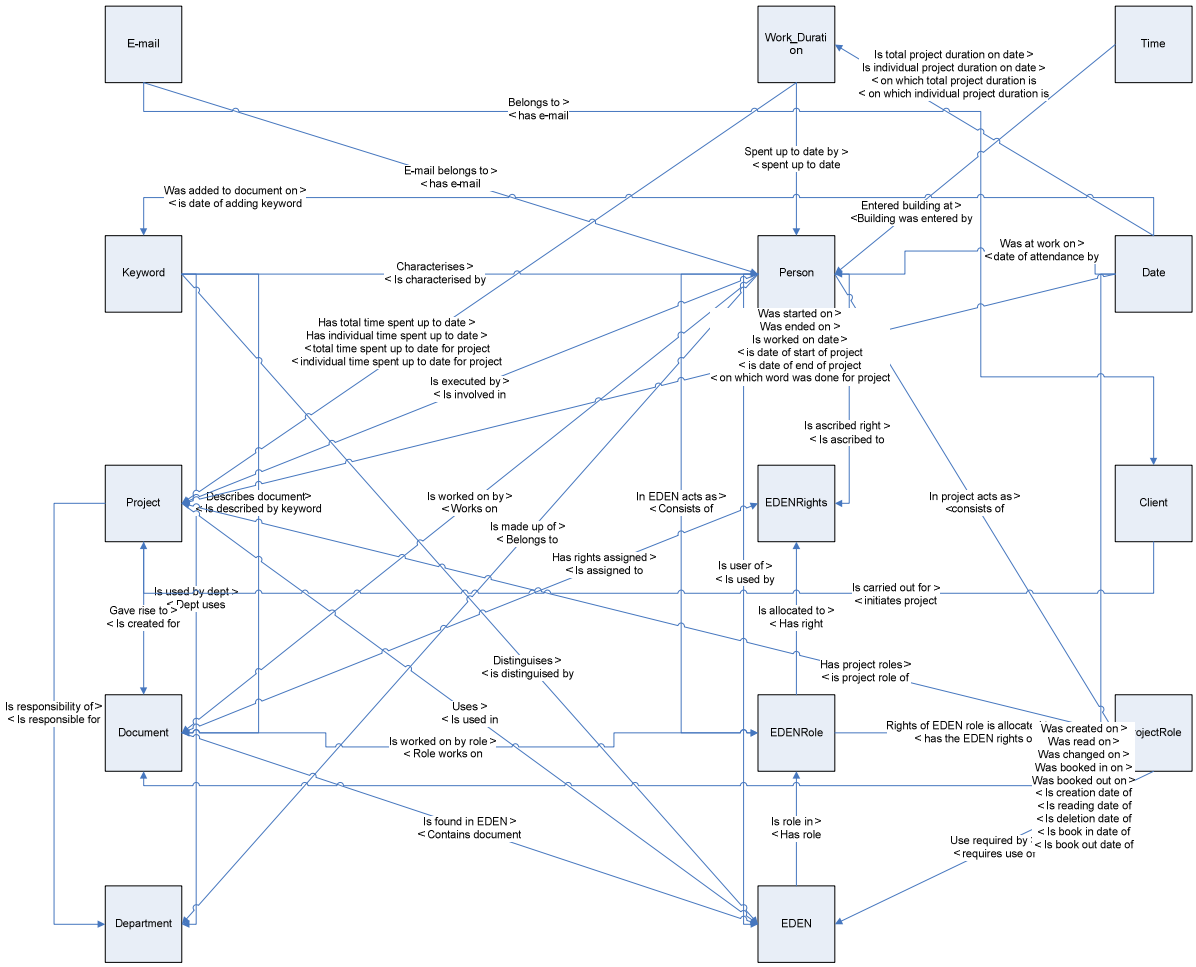


Figure 7.6: Refined type-relation structure of the Indutech conceptual framework implementation case study

the conceptual framework facts in this type-relation structure are not multi-directional – it only indicates a choice provided to the persons implementing the conceptual framework of text to use when constructing the conceptual framework in the conceptual framework software tool. The facts which ultimately made up the Indutech conceptual framework are listed in Appendix B.

Upon completion of the type-relation structure, it was verified by the project champion on both the information and logical level, which marked the end of the Analysis phase of the implementation.

Development

Fulfil conceptual framework hardware requirements

Once the size and complexity of the planned conceptual framework was known, sufficient data processing capabilities and storage space were obtained with the help of the project champion to facilitate the development of the Indutech conceptual framework.

Create and populate conceptual framework

In the case of the Indutech conceptual framework implementation, it was found that the conceptual framework could very easily be constructed by transferring the data contained in the respective information sources of the implementation domain to a Microsoft (MS) SQL Server database implementation, from where a mapping layer extension of the Organon conceptual framework software tool could obtain the data and transform it into the conceptual framework denoted by the type-relation structure shown in Figure 7.6.

Information from the implementation information sources were transferred to such a MS SQL Server database implementation at Indutech, with only a few complications:

- A small set of information was identified which did not exist explicitly within the implementation domain (see section B – Analysis phase), but rather as a shared understanding between Indutech employees. This information (the names of Indutech employees together with the corresponding departments they belong to) was however deemed crucial for ensuring the consistency and completeness of the Indutech conceptual framework, and was therefore collected formally in a MS Excel spreadsheet, which was subsequently transferred to the MS SQL Server database implementation.
- It was found that, in some cases, references to certain entities may differ in spelling from one information source to another. This clearly had severe consequences for accommodating the overlapping of information between these information sources, which necessitated cleaning of this data, ensuring that references to entities residing in different information sources are all spelled in the same manner. This problem of the existence of fractured information within the organisation's information sources is however not unique to Indutech, and will probably occur in most organisations. For this reason, this aspect is something to be prepared for when performing conceptual framework implementations, as it may require a large amount of time to address.
- Finally, it proved very labour intensive to transfer information from the MS Excel spreadsheet utilised by Indutech for timekeeping to the MS SQL Server database, due to the manner in which the data was captured in this spreadsheet.

Once all the relevant information resided in the MS SQL Server database, the mapping layer extension of the Organon conceptual framework software tool was used to compile this information into a conceptual framework (which will be discussed in more detail in the Final Result section). Finally, the creation and population of the conceptual framework was concluded through the investigation and verification of the conceptual framework's rationality, which was found to be intact.

Verify information represented by conceptual framework

A multi-disciplinary group of persons from Indutech and the GCC (see also section 5.1) was selected to verify the information represented by the Indutech conceptual framework, as well as to share their impressions of the conceptual framework approach and the implementation methodology. This group consisted of three researchers from the GCC, two software developers of Indutech, and the project champion.

The verification was done by providing each of the participants with a copy of the Indutech conceptual framework and a copy of the Organon software tool, and giving them the opportunity to first-hand experiment and interact with the conceptual framework. A questionnaire was also provided (see Appendix C), through which the impressions and suggestions of each person were captured. The contents of all these questionnaires were consolidated, and discussed during a final verification session held with the group. The issues discussed and the conclusions of these discussions will be discussed in more detail in the Observations section. The various participants of the verification activity agreed that the information represented by the conceptual framework was correct, and thereby verified the Indutech conceptual framework.

Implementation and Maintenance

After the conclusion of the Development phase of the conceptual framework implementation process, a decision was made by the project champion not to continue rolling out the approach to the rest of Indutech. This was due to the fact that there lacked a need for such a tool at the time of the implementation, and therefore the amount of effort required to perform the final two phases of the conceptual framework implementation process was not warranted. The case study concerning the implementation of a conceptual framework at Indutech was thereby concluded with the completion of the Development phase.

From the point of view of the persons performing the implementation of the Indutech conceptual framework, the implementation was a success. It was also deemed that the methodology functioned very effectively and that it addressed relevant issues during the different phases of the conceptual framework implementation.

• *Final Result*

The final result of the Indutech conceptual framework implementation case study was a conceptual framework consisting of more than 240,000 facts (see section 5.2.1), providing a view on the employees of Indutech, and the manner in which they work. Types of information that are

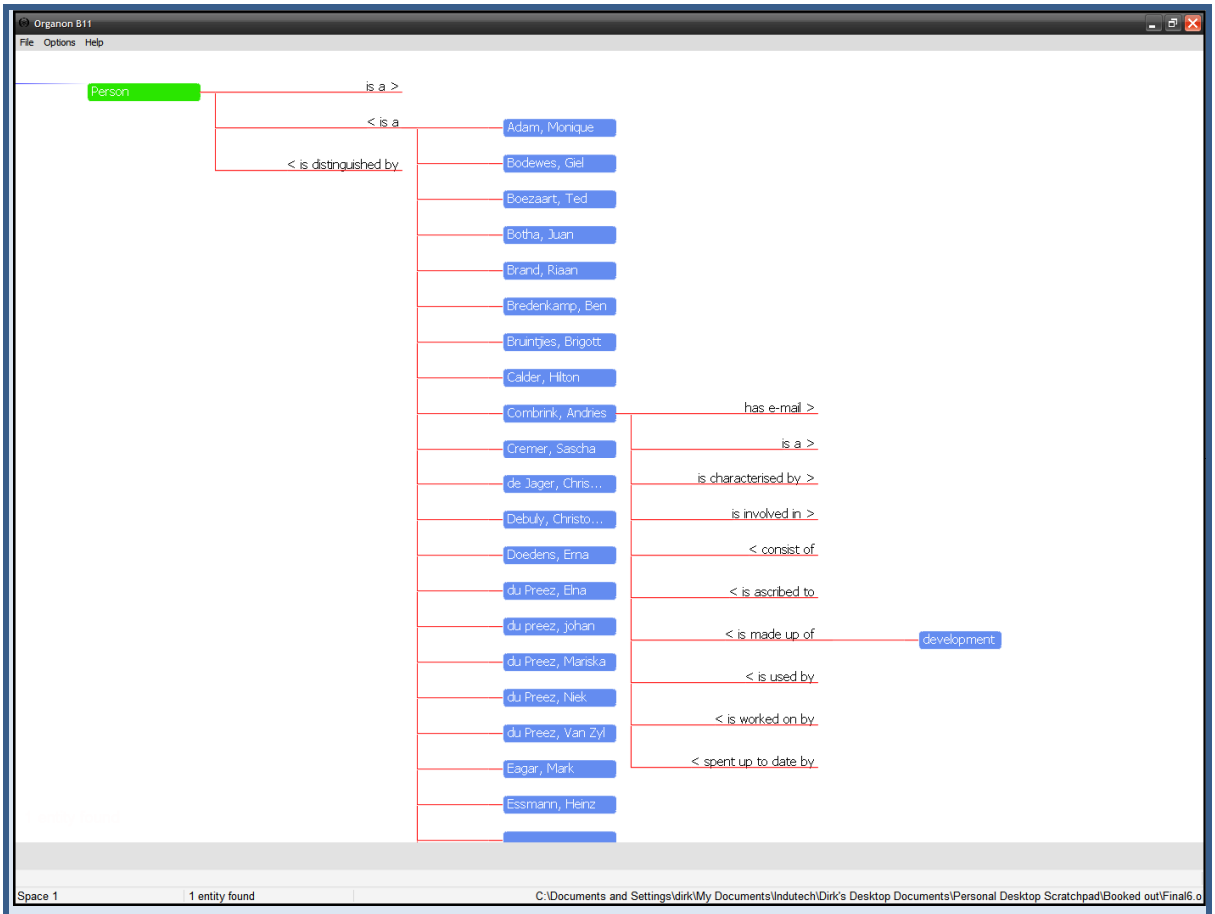


Figure 7.7: Screenshot 1 of Organon showing information of the Indutech conceptual framework implementation case study

Figure 7.7 shows the employees of Indutech (or **"Person"** entities), and some of the relations that pertain to entity "Combrink, Andries". It specifically indicates that this person belongs to the "Development" department[26], and also provides access to the following information on this person:

- The person's e-mail address
- The entity type of the person
- The keywords added by this person to Indutech documents (and which thereby characterises this person)
- The projects in which this person participated
- The roles this person assumed within the EDEN™ software environment
- The document access rights ascribed to the person within the EDEN™ software environment
- The EDEN™ databases that this person has accessed
- The documents on which this person has worked
- The time this person has spend up to a certain date on different projects

[26] *The "<" and ">" characters indicate the direction in which the text of a relation is applied, e.g. "Adam, Monique"* "is a" *"Person".*

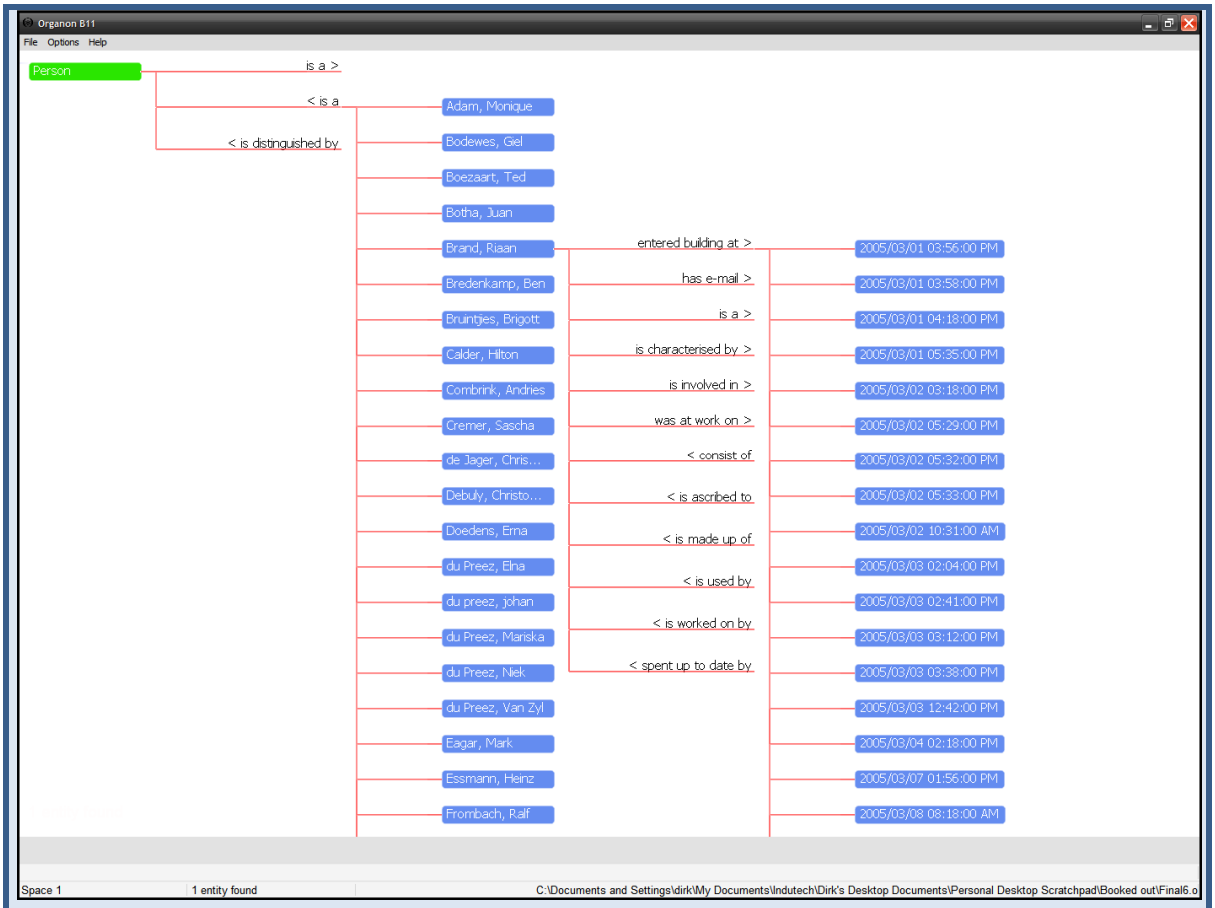


Figure 7.8: Screenshot 2 of Organon showing information of the Indutech conceptual framework implementation case study

Figure 7.8 shows the relations of **"Person"** entity "Brand, Riaan" and focuses on dates and times which he arrived at Indutech, and entered the premises through use of the BioAccess biometric access control system. Access to the following information on this person is also provided:

- The person's e-mail address
- The entity type of the person
- The keywords added by this person to Indutech documents (and which thereby characterises this person)
- The projects in which this person participated
- The dates on which this person was at work
- The roles this person assumed within the EDEN™ software environment
- The document access rights ascribed to the person within the EDEN™ software environment
- The department to which this person belongs
- The EDEN™ databases that this person has accessed
- The documents on which this person has worked
- The time this person has spend up to a certain date on different projects

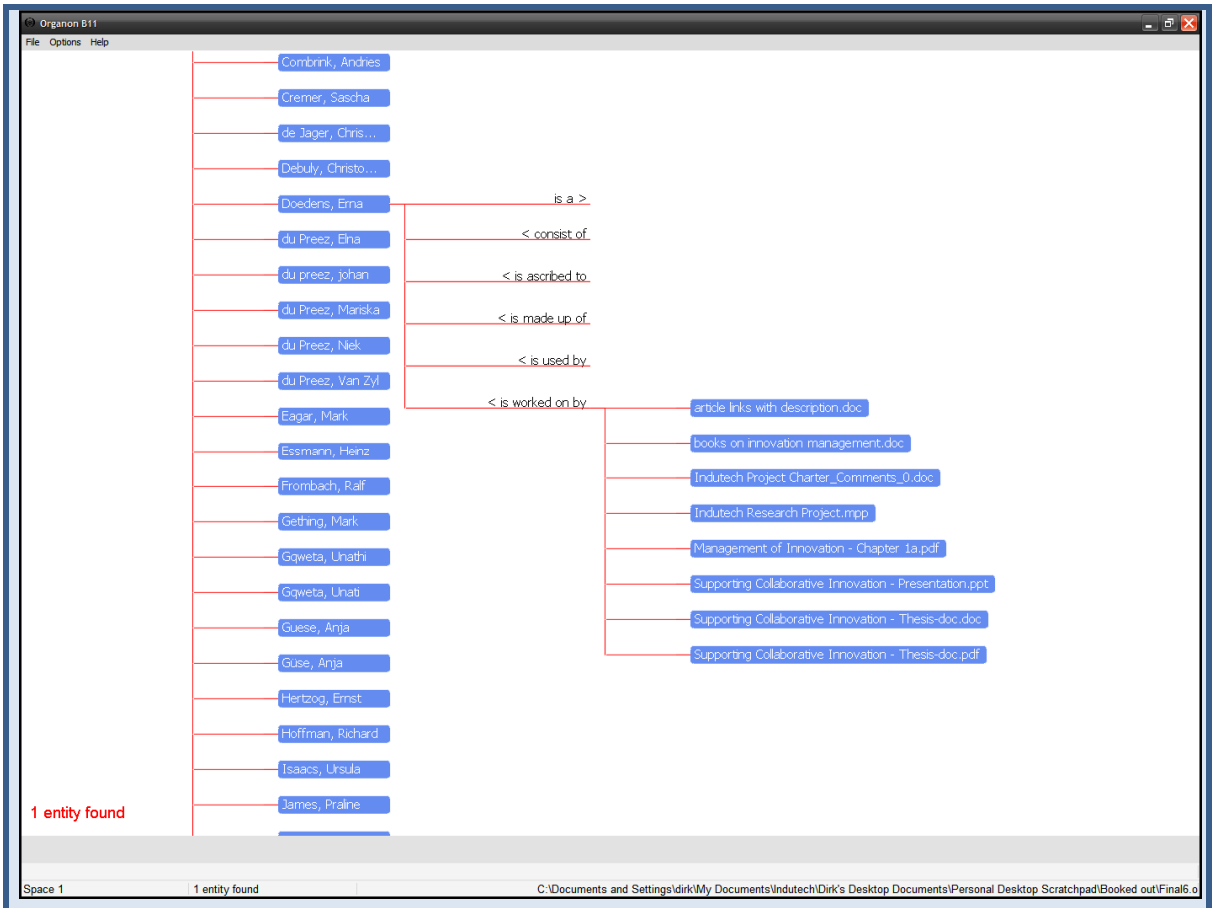


Figure 7.9: Screenshot 3 of Organon showing information of the Indutech conceptual framework implementation case study

Figure 7.9 shows the **"Person"** "Doedens, Erna" and the documents residing in the EDEN™ databases which she had worked on. Access to the following information on this person is also provided:

- The entity type of the person
- The roles this person assumed within the EDEN™ software environment
- The document access rights ascribed to the person within the EDEN™ software environment
- The department to which this person belongs
- The EDEN™ databases that this person has accessed

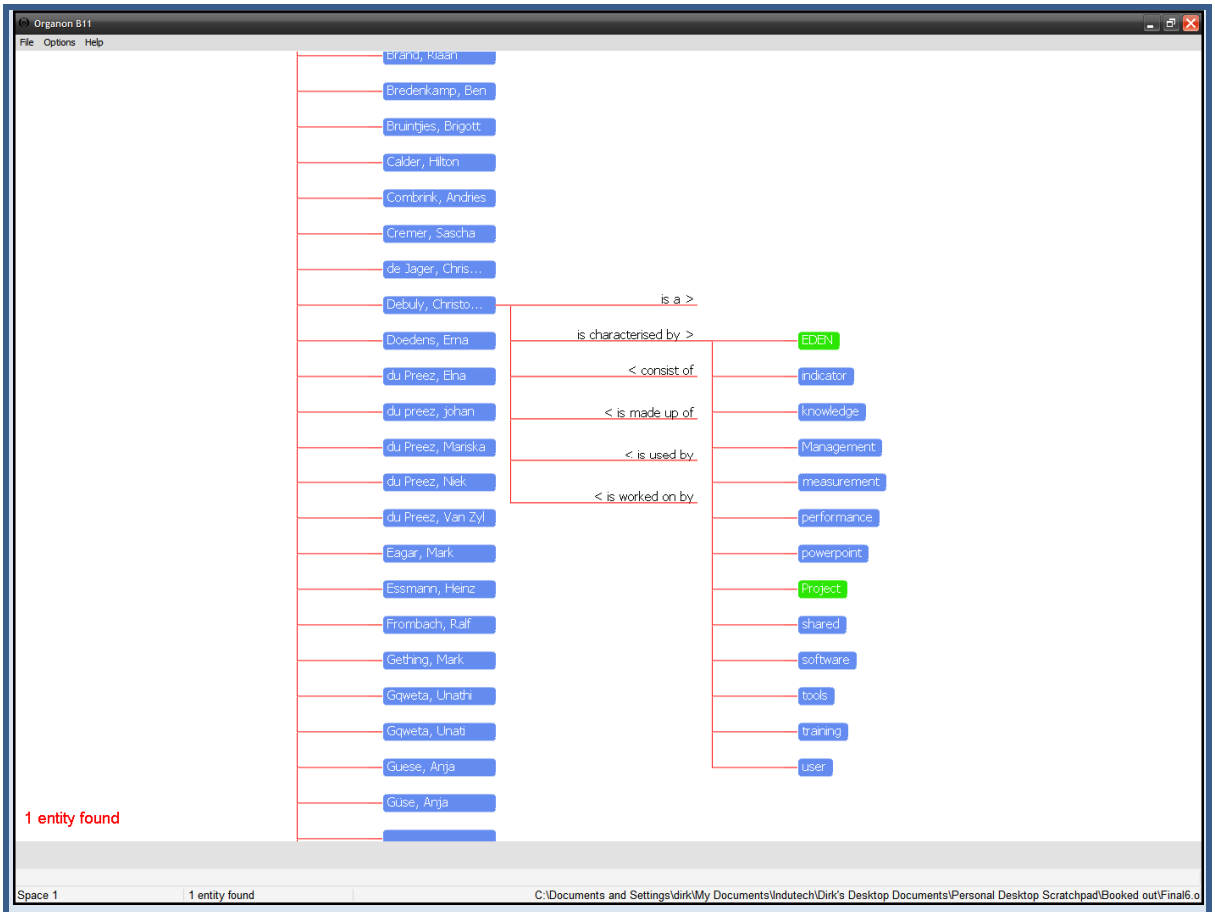


Figure 7.10: Screenshot 4 of Organon showing information of the Indutech conceptual framework implementation case study

Figure 7.10 shows the **"Person"** "Debuly, Christophe" and the keywords that he has attached to documents in the EDEN™ databases that he has worked on. This view can be useful for a person interested in knowing what type of work another person is involved with. Access to the following information on this person is also provided:

- The entity type of the person
- The roles this person assumed within the EDEN™ software environment
- The department to which this person belongs
- The EDEN™ databases that this person has accessed
- The documents on which this person has worked

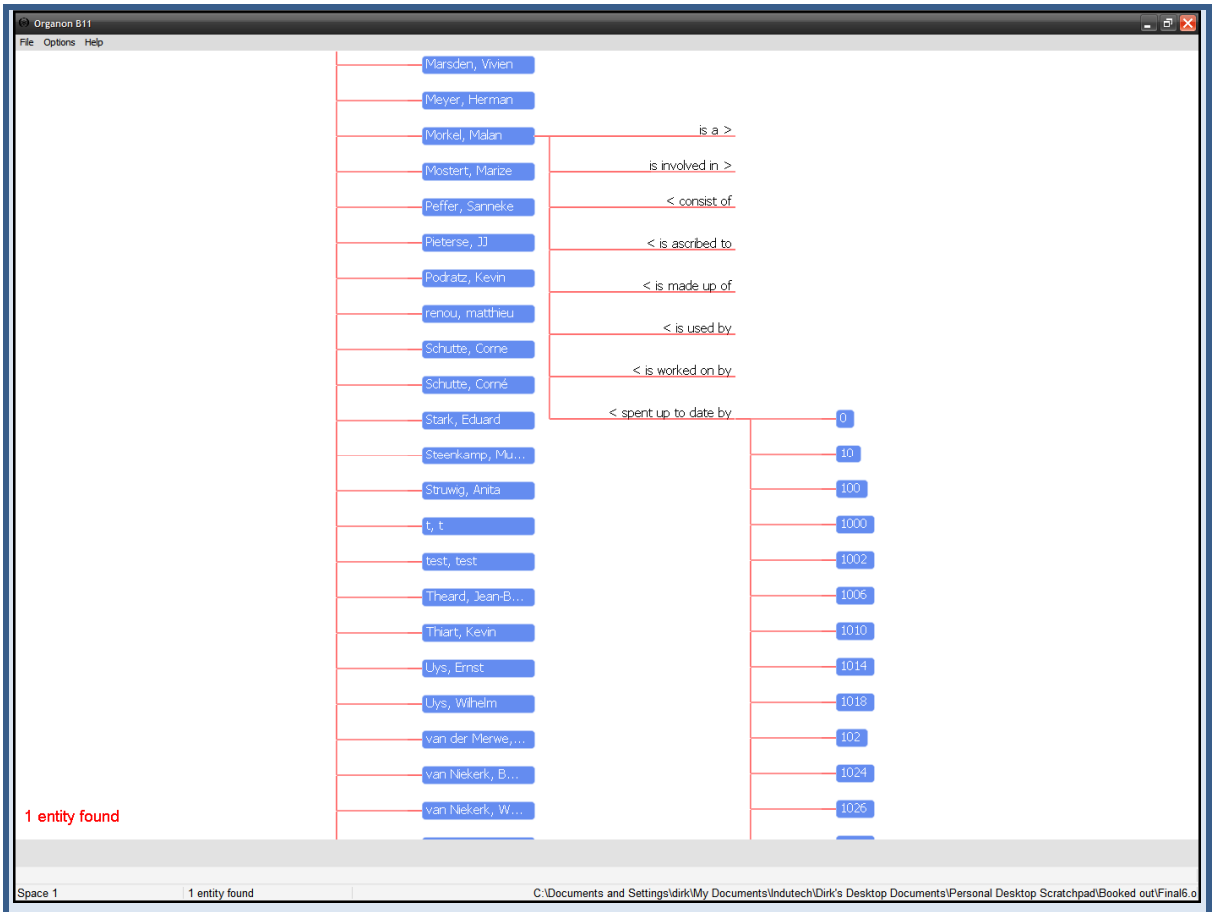


Figure 7.11: Screenshot 5 of Organon showing information of the Indutech conceptual framework implementation case study

Figure 7.11 shows the **"Person"** "Morkel, Malan" and the amount of hours he has spent on different projects (both daily and up to date totals), as well as access provided to the following information on this person:

- The entity type of the person
- The projects in which this person participated
- The roles this person assumed within the EDEN™ software environment
- The document access rights ascribed to the person within the EDEN™ software environment
- The department to which this person belongs
- The EDEN™ databases that this person has accessed
- The documents on which this person has worked

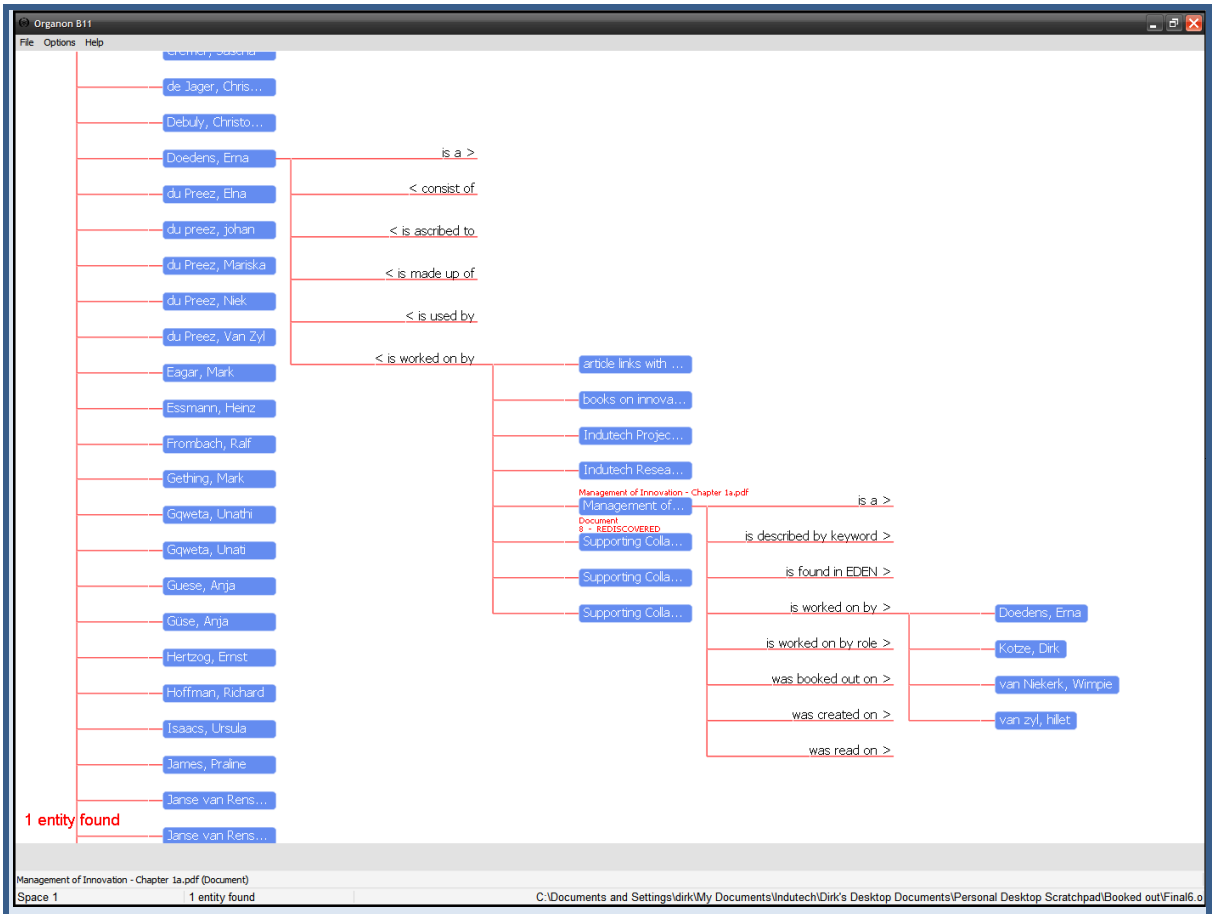


Figure 7.12: Screenshot 6 of Organon showing information of the Indutech conceptual framework implementation case study

Figure 7.12 shows the **"Document"** "Management of Innovation – Chapter 1a.pdf" which was worked on by the **"Person"** "Doedens, Erna", as well as the names of all persons that has worked on the document, namely "Doedens, Erna", "Kotze, Dirk", "van Niekerk, Wimpie" and "van zyl, hillet". Access to the following information on this document is also provided:

- The entity type of the document
- The keywords that have been used to describe this document
- The EDEN™ database in which this document resides
- The EDEN™ roles of the persons that have worked on this document
- The dates on which a user have booked this document out of EDEN™
- The date on which this document was created in EDEN™
- The dates on which users have accessed this document in EDEN™

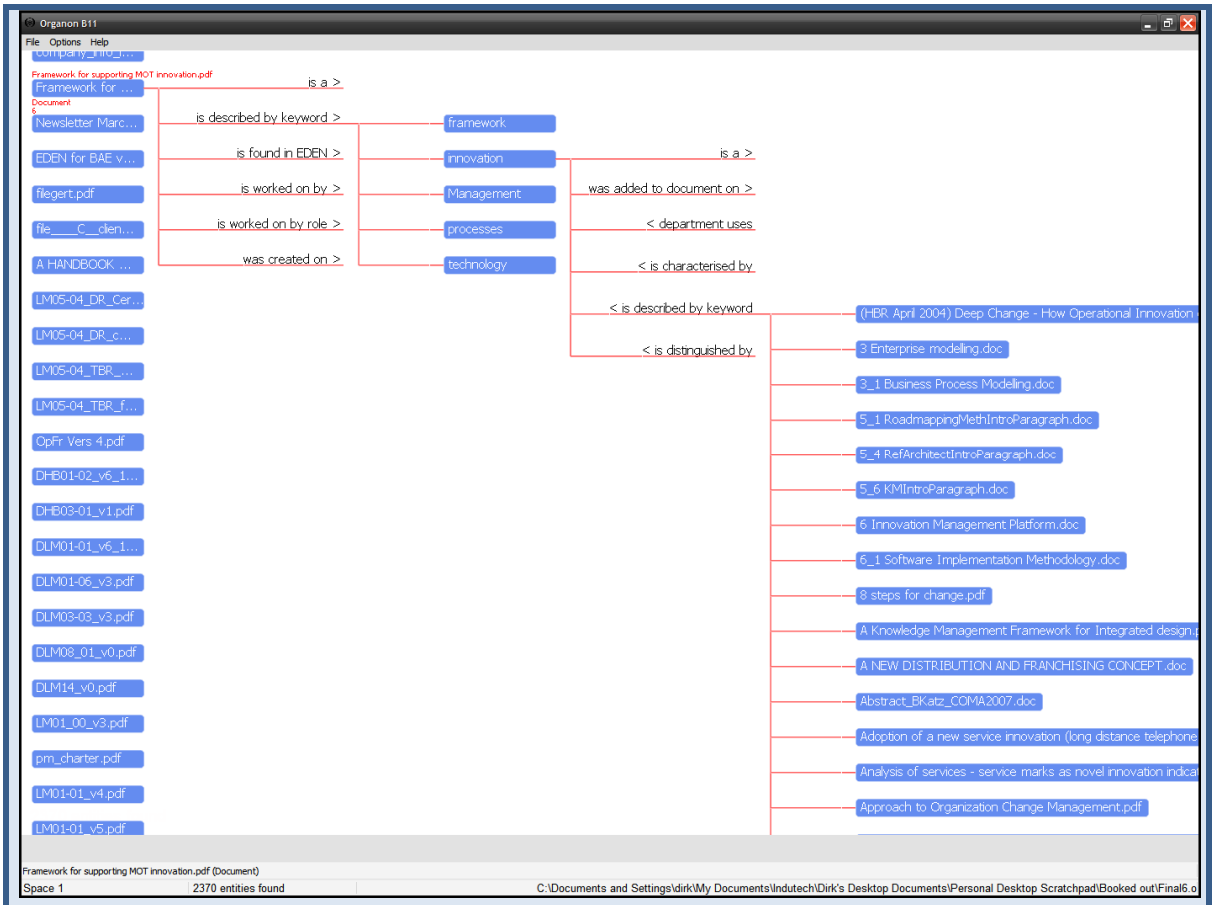


Figure 7.13: Screenshot 7 of Organon showing information of the Indutech conceptual framework implementation case study

Figure 7.13 shows the **"Document"** "Framework for supporting MOT innovation.pdf" together with the keywords that was used to describe it in the EDEN™ database in which it resides. Other documents are also shown which share the use of the keyword "innovation" with "Framework for supporting MOT innovation.pdf". Access is also provided to the following information on this keyword:

- The entity type of the keyword
- The date this keyword was associated with a document
- The departments that make use of this keyword
- The persons that have used this keyword
- The EDEN™ database in which this keyword is used

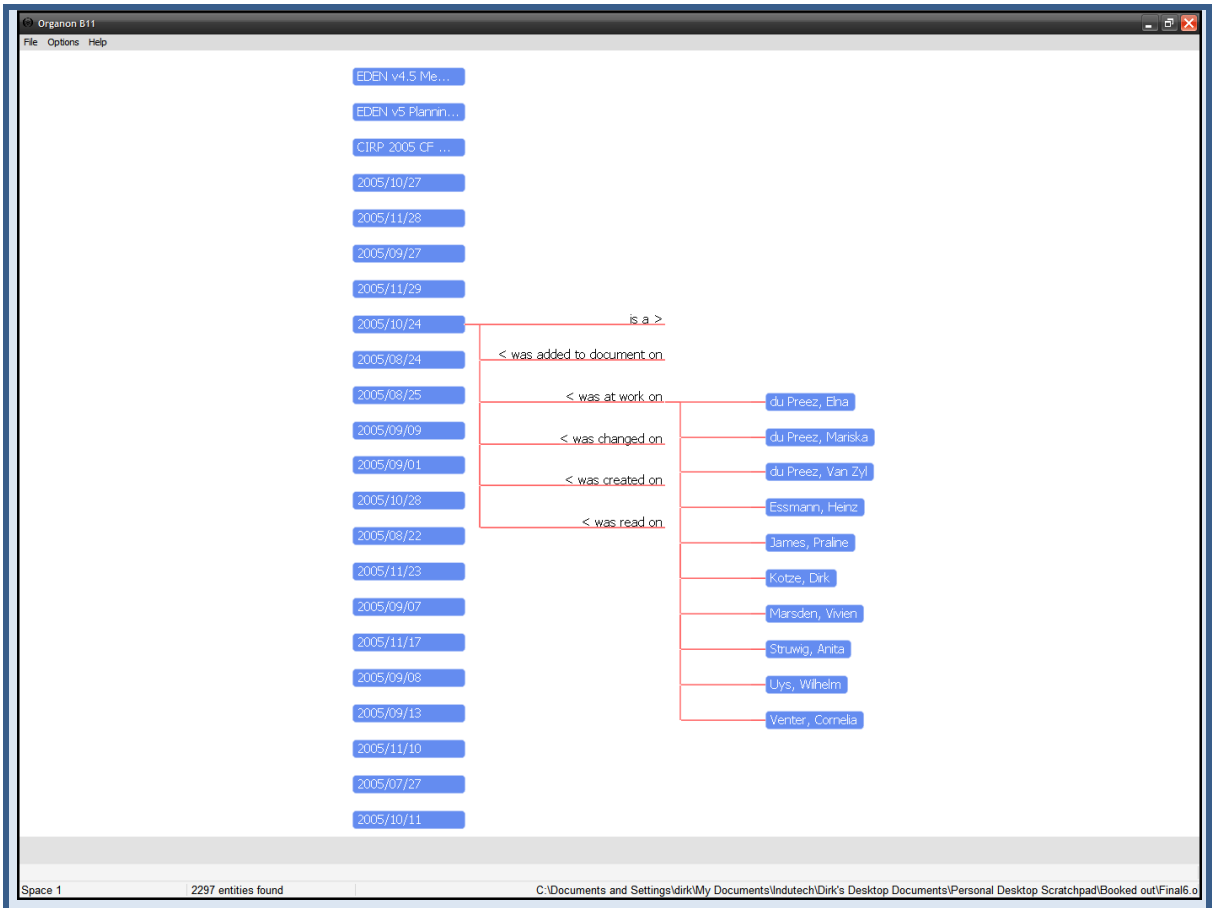


Figure 7.14: Screenshot 8 of Organon showing information of the Indutech conceptual framework implementation case study

Figure 7.14 shows the **"Date"** "2005/10/24", as well as the persons who was at work on that day (which is strictly speaking not entirely correct, as employees often arrive at Indutech in groups, and usually only one person from such a group makes use of the BioAccess biometric access control system to ensure access to the premises for all). Access is also provided to the following information associated with this date:

- The entity type of the date
- The keywords added to documents on this date
- The documents that changed in EDEN™ on this date
- The documents that was created in EDEN™ on this date
- The documents that was accessed in EDEN™ on this date

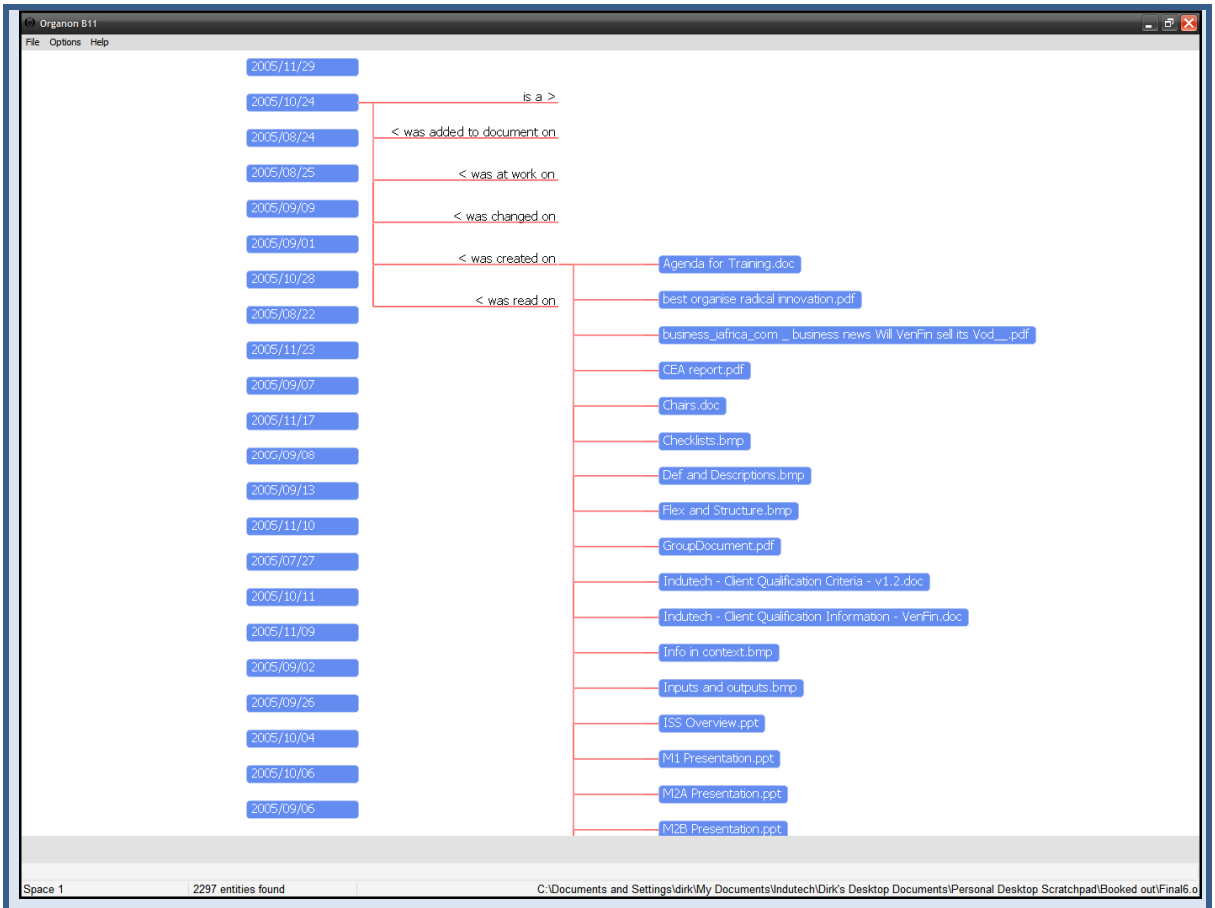


Figure 7.15: Screenshot 9 of Organon showing information of the Indutech conceptual framework implementation case study

Figure 7.15 shows the **"Date"** "2005/10/24", as well as the documents that were created on this date, together with access provided to the following information associated with this date:

- The entity type of the date
- The keywords added to documents on this date
- The persons who were at work on this date
- The documents that changed in EDEN™ on this date
- The documents that was accessed in EDEN™ on this date

Executive Development and the coastal town of Saldanha serves as the base for the Faculty of Military Sciences" (About Stellenbosch University 2007).

The Information Technology (IT) division of Stellenbosch University (SU) (which will henceforth be referred to as the *organisation* for consistency's sake) was approached to be the site for the second case study for testing the conceptual framework implementation methodology. This site was chosen because the department could provide access to a wide variety of different types of information (much like in a typical organisation) through which the implementation methodology could be thoroughly tested, whilst also standing sympathetic towards research conducted into information management by a student of the university, therefore providing more assistance and access to information than could otherwise have been expected from a more typical organisation. Therefore, similar to the Indutech case study, the SU IT conceptual framework implementation also took place in a somewhat benign environment, but the extent of the implementation was much larger than the one conducted previously, and was aimed to properly test the implementation methodology and software tool that was developed.

• *The implementation process*

As with the first case study, the implementation process of the SU IT conceptual framework will be discussed in terms of the five phases of the conceptual framework implementation methodology.

Planning

Identify stakeholders

In the case of the SU IT case study, a project champion was not selected, as the persons involved from the organisation's side preferred to play a less prominent role in the driving of the implementation process, and wished rather to be involved only where information identification, extraction and verification was required. A mixed team from the GCC and Indutech therefore performed the largest portion of the implementation with the organisational stakeholders only contributing to certain activities of the SU IT conceptual framework implementation process. Based on their respective roles in the process, the participants from the organisation were divided into *principal*, *primary* and *secondary* stakeholders. The designations of these persons are indicated below (see also Appendix D):

- **Principal Stakeholder**
    - Senior Director: Information Technology

- **Primary Stakeholders**
    - Director: Administrative Information
    - Director: User Services
    - Director: e-Business and Card Facility Manager
- **Secondary Stakeholders**
    - Manager: Student Information Systems
    - Head Engineer: Systems Integration
    - Contact person – WebCT[29] Reporting Information
    - Manager: Access Control
    - Contact person – Printing Transaction Information
    - Senior Software Specialist: Library Services

Initial information need identification

The stakeholders of the SU IT conceptual framework implementation decided to let the case study take the form of a pilot study for the ascertaining of the benefits and shortcomings of the conceptual framework based approach for viewing and utilising organisational information. The domain of organisational information on which the implementation was to focus, was information on student interaction with the organisational information infrastructure. As sources of information for the SU IT conceptual framework, six domains of information within the organisational environment were identified (listed below):

- Card reader transaction information, which is information captured whenever a student swipes his/her student card through an organisation card reader. Five different types of card reader transactions were identified to be included in the implementation, namely access control transactions, photocopying transactions, washing transactions, meal transactions and vehicle pool transactions.
- Demographic and study programme information, which is student demographical information and information on the modules, programme, etc. that a student is currently enrolled for.[30]
- Internet usage cost information, which focuses on the amounts of internet bandwidth utilised by students over/during certain periods.[31]

[29] *An e-learning system, now owned by Blackboard Inc. (http://www.blackboard.com)*

[30] *Due to obvious privacy issues, this information did not include the marks that students achieved for any modules or the respective programmes they are enrolled for.*

- Library transaction and item information, which is information on transactions conducted by students at any of the libraries of the organisation, as well as information on the library items found within the organisation's library system.
- Printing transaction information is information captured whenever a student performs a printing transaction using an organisation printer.
- WebCT usage information, which is information focusing on student interaction with the organisation's e-learning environment, WebCT.

The stakeholders did not pose any specific questions which the conceptual framework constructed from the information listed above were meant to address. A decision was made to rather construct a conceptual framework that is based solely on the types of information that exist within the six organisational information domains, and on the interpretation of the persons that perform the conceptual framework implementation.

Analysis

Examination of information sources pertaining to stakeholder-specified information requirements

The examination of the information found in each of the domains listed in the previous section was done in a less formal manner than is prescribed by the conceptual framework implementation methodology. Meetings were held with each of the secondary stakeholders mentioned in the previous section, with the focus being only to determine the different types of information found in each particular domain. The reason why a more in-depth analysis of the information was not performed, is because of the fact that the implementation was only seen as a pilot study through which the organisation was to acquire a new view on its own information. For security reasons it was therefore preferred that the persons who perform the implementation have as little direct interaction with the organisational information infrastructure as possible until such a time that the approach has been accepted, and a decision made to formally integrate the conceptual framework approach with the organisation's information infrastructure.

Development of conceptual framework specification

From information gathered through meetings held with the secondary stakeholders of the SU IT conceptual framework implementation (discussed in the previous section), a total of sixty-five

[31] *Again, due to obvious privacy issues, information relating to the internet addresses that are visited by students when accessing the internet was omitted.*

(65) conceptual framework types were identified. These types, together with their descriptions can be seen in Table 7.4.

Table 7.4: Names and descriptions of conceptual framework types identified in SU IT conceptual framework implementation case study

Entity Name	Description
Age	Age of a SU student or a library item
Date	Any references made to dates in the SU IT environment being mapped. This include the following: • Dates of card reader transactions; • Dates of internet transactions; • Dates of library transactions; • Dates of printing transactions; and • Dates of WebCT actions.
Document Type	Types of documents, e.g. MS Word documents, MS Excel documents, PDF documents, etc. (mainly related to printing operations)
Education department	Denoting a South African education department, from which a scholar can receive a senior certificate used in applying for study at the SU
File Size	Byte size of a computer file (mainly related to printing operations)
Gender	Male/Female
Handicap	Manner of handicap experienced by a SU student (this includes wheelchair handicap)
High school	High school attended by a SU student
Language	Language spoken by a SU student, as well as language a library item was written in
Library Branch	Branch of the SU library services where items can be loaned to students
Library Database Name	Name of an on-line information database managed by the SU library, and which can be accessed by students through a web-portal
Library Dewey Classification	Number of a library item corresponding to a numbering system utilised by the SU library to categorise its items
Library Item Author	Author of a library item

Entity Name	Description
Library Item Collection	Indication of the type of SU library material (e.g. reference material)
Library Item Loan Amount	Amount of times library items have been loaned
Library Item Material	Media format of a SU library item
Library Item Publisher	Publisher of a SU library item
Library Item Status	Status of a SU library item
Library Item Subject Topic	Broad topic that includes a specific SU library item
Library Item Title	Title of a SU library item
Library Item Vendor	Vendor of a SU library item
Library Shelf Code	Shelf code where a SU library item is stored
Library Shelf Code Type	Distinguishes between different shelf code systems used by the SU library
Library Transaction Location	Indicates whether a SU library transaction was conducted at the counter in the library, or through a web portal
Library Transaction Patron Type	Type of person performing a certain transaction at the SU library
Library Transaction Type	Type of transaction performed at the SU library
Marital status	Marital status of a SU student
Nationality	Nationality of a SU student
Network traffic	Network usage experienced by SU IT systems (mainly indicates internet usage and usage of SU library on-line information sources in bytes per hour)
Number of pages	Number of pages used through printing and photo-copying activities
Page Cost	Page cost of printing and photocopying activities
Person	User of the SU IT system, accessing the system through a student number or computer username. This includes the usage of card readers, internet access, printing and library services and WebCT. It further provides access to academic and demographic information stored by the SU on its students.
Population group	Population group of a SU student
Postal code	Postal code of SU student

Entity Name	Description
Time band	Any references to time made in the SU IT system, grouped in time bands. This include the following: • Times of card reader transactions; • Times of internet transactions; • Times of library transactions; • Times of printing transactions; and • Times of WebCT actions.
Town	Home town of SU students, as well as cities where certain publishers of SU library items are situated
US Campus	Indicates one of the four main SU campuses: Stellenbosch Main Campus, Bellville Campus (SU Business School), Tygerberg Campus (Health Sciences) and the Saldanha Military Academy.
US Card Reader	Name of a US card reader
US Card Reader Type	Indicating type of SU card reader (e.g. door access, photo copier, washing equipment, etc.)
US Department	Department of the SU
US Faculty	Faculty of the SU
US Module	Module (or subject) taken by SU student and presented by a SU department
US Photocopier	Name of a SU photocopier
US Printer	Name of a SU printer
US Programme	Name of a programme presented by the SU
US Programme Continuity	Indicates whether a programme is studied full-time or part-time
US Qualification	Type of SU qualification that can be attained by a student, e.g. degree, diploma, certificate, etc.
US Residence	Name of a SU residence. Only applicable to the usage of card readers with regards to washing equipment
US Residence Type	Indicates a type of SU residence, e.g. hostel, student house, etc.
US Vehicle License Plate	License plate number of a SU vehicle in the SU motor pool
US Washing Equipment	Type of SU washing equipment that can be used by SU students, e.g. washing machine, tumble drier, etc.

Entity Name	Description
US Workstation/PC	Name of a SU workstation or PC used for printing of documents and internet access
WebCT Action	Action performed by a user in the SU WebCT environment
WebCT Dwell time	Time spent by a user in the SU WebCT environment between actions
WebCT Event Role	Role of a user when performing an action in the WebCT environment
WebCT Learning Context	Learning context in the WebCT environment
WebCT Learning Context Administrative Period	Period for which a specific WebCT learning context is accessible
WebCT Learning Context Role	The role of a user in a specific learning context
WebCT Learning Context Type	Indicates the level where a learning context can be found in the WebCT environment
WebCT Number	Any references to numbers in the WebCT environment, usually used in reporting the contents of WebCT templates and WebCT learning contexts
WebCT Organisation	Name of organisation using specific WebCT learning contexts
WebCT Organisation Type	Value distinguishing general categories of the organisation
WebCT Organisation Unit	Name of sponsoring/administering unit within the organisation
WebCT Size	Any references to sizes in the WebCT environment, usually used in reporting file sizes
WebCT Template	Component of WebCT learning context that can be utilised by users

A total of one thousand and twenty-two (1,022) conceptual framework relations were defined between the types (which were still less than half of the $\frac{1}{2}(n^2+n) = \frac{1}{2}(65^2+65) = 2145$ potential relations predicted by the conceptual framework implementation methodology), again by employing the matrix approach mentioned in section B – Analysis phase. In the case of the SU IT conceptual framework case study this approach proved to be extremely time-consuming as there was no information on the internal structure of the organisational information sources to guide this activity, which meant that all the possible combinations of type-pairs that could be identified had to be evaluated from a purely logical viewpoint and for each case the decision made if a relation exists between a particular pair of types. Because of time constraints, and the fact that the definition of relations were so time-consuming, not all of the relations that might possibly exist within the information constituting the SU IT conceptual framework were

- Library transaction information.

The principal stakeholder furthermore proposed to have each of the domains in question prepare a set of data (which is representative of that domain) from which the conceptual framework could be created. This was done for two reasons: firstly, because the organisation had to encrypt sensitive student-specific information that form part of the domain information (like student numbers) in order to protect student privacy; and secondly, because it negated the need for direct interaction by external parties with the organisational information infrastructure, which was preferred from a security viewpoint. The delivery of this packaged information initiated the Development phase of the SU IT conceptual framework implementation.

Development

Fulfil conceptual framework hardware requirements

Due to the fact that the SU IT conceptual framework implementation was seen as a pilot study, hardware requirements were not fulfilled by the organisation. It was decided to construct the conceptual framework off-site at the Indutech premises using Indutech hardware and software, and only once the implementation stakeholders of Stellenbosch University have seen the result of the study and indicated their willingness to perform a proper conceptual framework implementation would the ensuing SU IT conceptual framework be integrated with the organisation's information infrastructure.

Create and populate conceptual framework

Similar to the Indutech conceptual framework implementation, the data from the various Stellenbosch University information domains were transferred to a MS SQL Server database implementation at Indutech from where the mapping layer extension of the Organon conceptual framework software tool could obtain the data and transform it into a conceptual framework. No real complications were experienced in creating a conceptual framework from the data residing in the MS SQL Server database. The only difficulty that was encountered was that the Organon software was unable to manage the masses of information that were generated through the creation of the SU IT conceptual framework. A decision was therefore made to further reduce the number of students around which the conceptual framework was to be constructed (to 424), as well as to reduce the timeframe of the conceptual framework to one month (August 2007). This resulted in a conceptual framework that fortunately was still deemed sufficiently complex to provide stakeholders with a clear view on the potential of the conceptual framework approach in their organisation. Once the creation and population of the SU IT conceptual framework (which will be discussed in more detail in the Final Result section) was

completed, the rationality of the conceptual framework was investigated and verified successfully.

Verify information represented by conceptual framework

Verification of the SU IT conceptual framework took place in two stages. First, the conceptual framework was demonstrated and discussed through one-on-one contact sessions with each of the secondary stakeholders who supplied information for inclusion in the SU IT conceptual framework. During these sessions emphasis were placed specifically on the domain that each person are responsible for, and whether the information from that domain is represented correctly by the SU IT conceptual framework. Other aspects that were also discussed in a more general fashion, were whether the particular secondary stakeholder could see the benefit of the conceptual framework information modelling approach in their own environment, and what other information within the organisational information environment could be added to the conceptual framework to make it even more useful.

The second stage of the SU IT conceptual framework verification was done as a demonstration of the conceptual framework to a group of persons consisting of the principal stake holder of the implementation, one of the primary stake holders of the implementation and two researchers from the GCC. During this session, the process that was followed to construct the conceptual framework was discussed, and the participants from the organisation asked to verify the correctness of the information as represented by the conceptual framework. Furthermore the benefits and shortcomings of the conceptual framework were discussed, as well as the manners in which the conceptual framework could be improved.

Unlike the first case study, the participants in the conceptual framework verification discussions were not each provided with a personal copy of the conceptual framework that was developed, and therefore could not verify the information in the SU IT conceptual framework based on first-hand experimentation and interaction. It was deemed sufficient however, to have the participants verify the information represented by the conceptual framework through their comments and impressions during the verification discussions. These comments and impressions were captured in questionnaires (see Appendix E) that each of the participants were asked to complete subsequent to the discussions.[33] Through specifically directed questions in the questionnaire, it was established that the information represented by the conceptual framework was correct, which therefore verified the SU IT conceptual framework.

[33] *The results of which will be discussed (together with other comments and impressions gathered during the verification discussion) in more detail in the Observations section.*

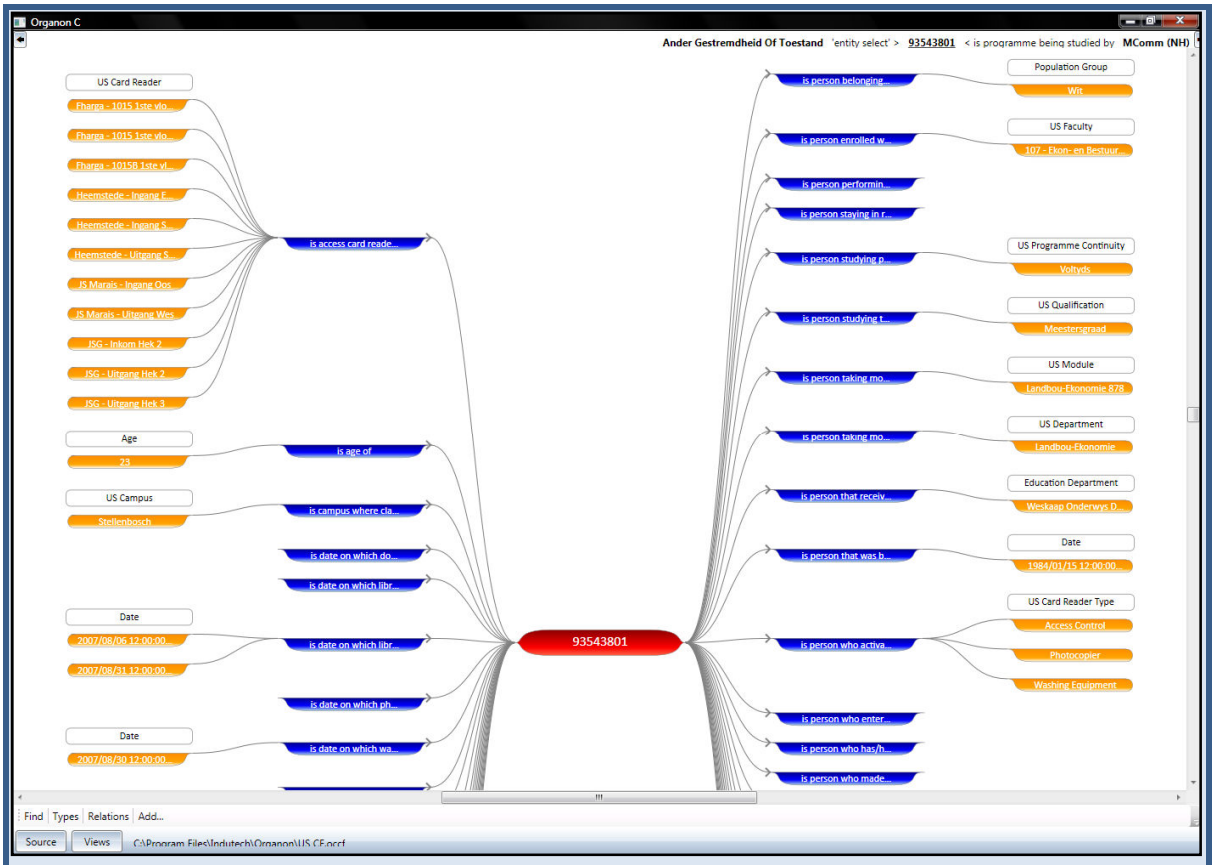


Figure 7.17: Screenshot 1 of Organon showing information of the SU IT conceptual framework implementation case study

Figure 7.17 shows a **"Person"** entity named "93543801", and some of the relations that pertain to this entity. It furthermore indicates the following information about this person:

- The university card readers this person utilises to gain access to various buildings on the university campus
- The age of this person
- The campus where this person attends class
- Dates on which library transactions were performed by this person
- Dates on which washing equipment was used by this person
- The population group this person belongs to
- The faculty where this person is enrolled
- The manner in which this person studies his/her course, which is full-time
- The type of qualification this person is studying towards, which is a master's degree
- The module(s) this person is taking as part of his/her course
- The department where this person is taking his/her module(s)
- The education department where this person received his/her senior certificate
- The person's date of birth
- The types of university card readers this person uses

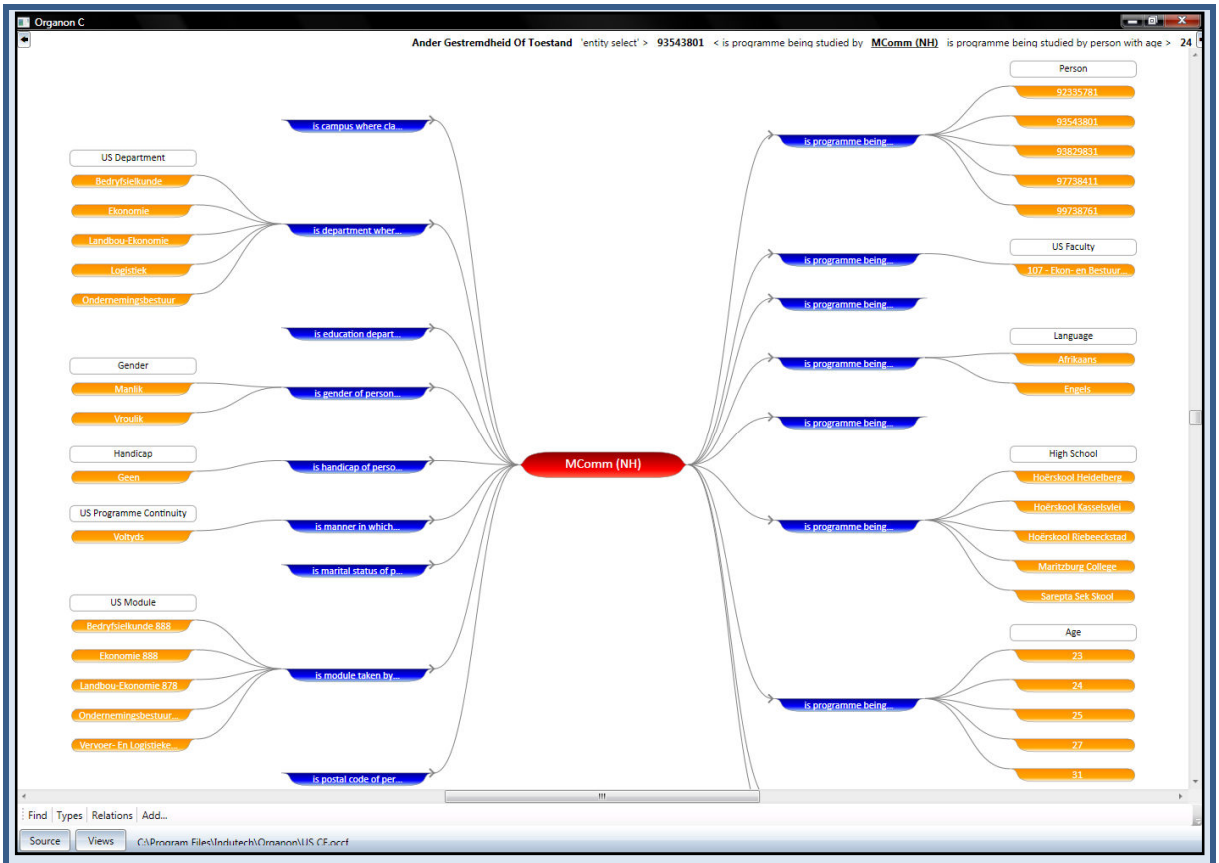


Figure 7.18: Screenshot 2 of Organon showing information of the SU IT conceptual framework implementation case study

Figure 7.18 shows a **"US Programme"** entity named "MComm (NH)" (which is the course studied by person "93543801" of the previous screenshot), and some of the relations that pertain to this entity. It furthermore indicates the following information about this programme:

- The university departments where persons studying this course take their modules
- The genders of persons studying this course
- The manner in which persons studying this course aim to achieve their qualification, which is full-time
- The modules taken by persons studying this course
- The handicaps of persons studying this course
- The persons studying this course (which obviously include person "93543801")
- The faculty that at which persons are enrolled in order to study this particular course
- The home languages of persons studying this course
- The high schools attended by persons studying this course
- The current ages of persons studying this course

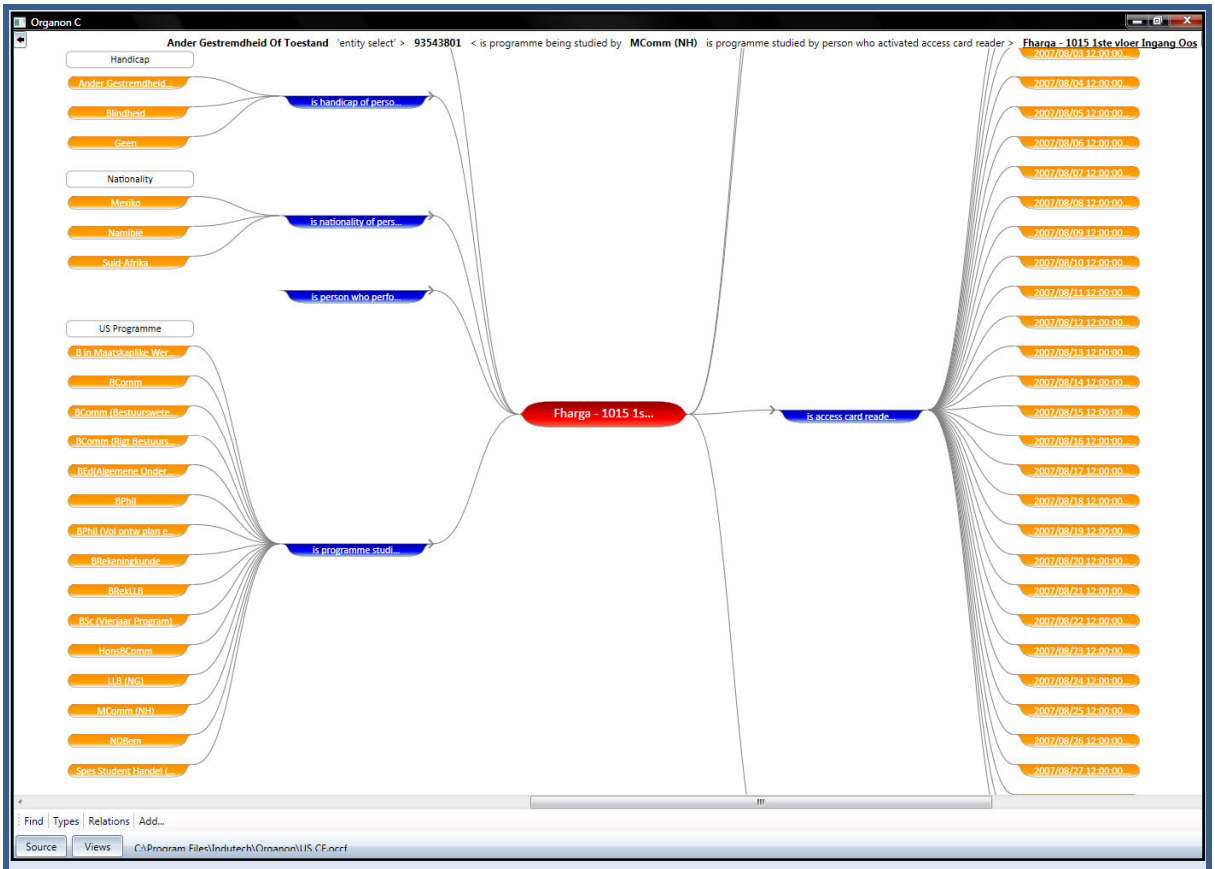


Figure 7.19: Screenshot 3 of Organon showing information of the SU IT conceptual framework implementation case study

Figure 7.19 shows a **"US Card Reader"** entity named "Fharga 1015 1ste vloer Ingang Oos" (or Fharga 1015 1st floor Entrance East, which is one of the access card readers utilised by persons studying SU Programme "MComm (NH)", discussed in the previous screenshot), together with some of the relations that pertain to this entity. The following information on this particular card reader is also provided:

- The handicaps of persons utilising this card reader
- The nationalities of persons utilising this card reader
- The courses studied by persons utilising this card reader
- The dates on which this card reader was utilised

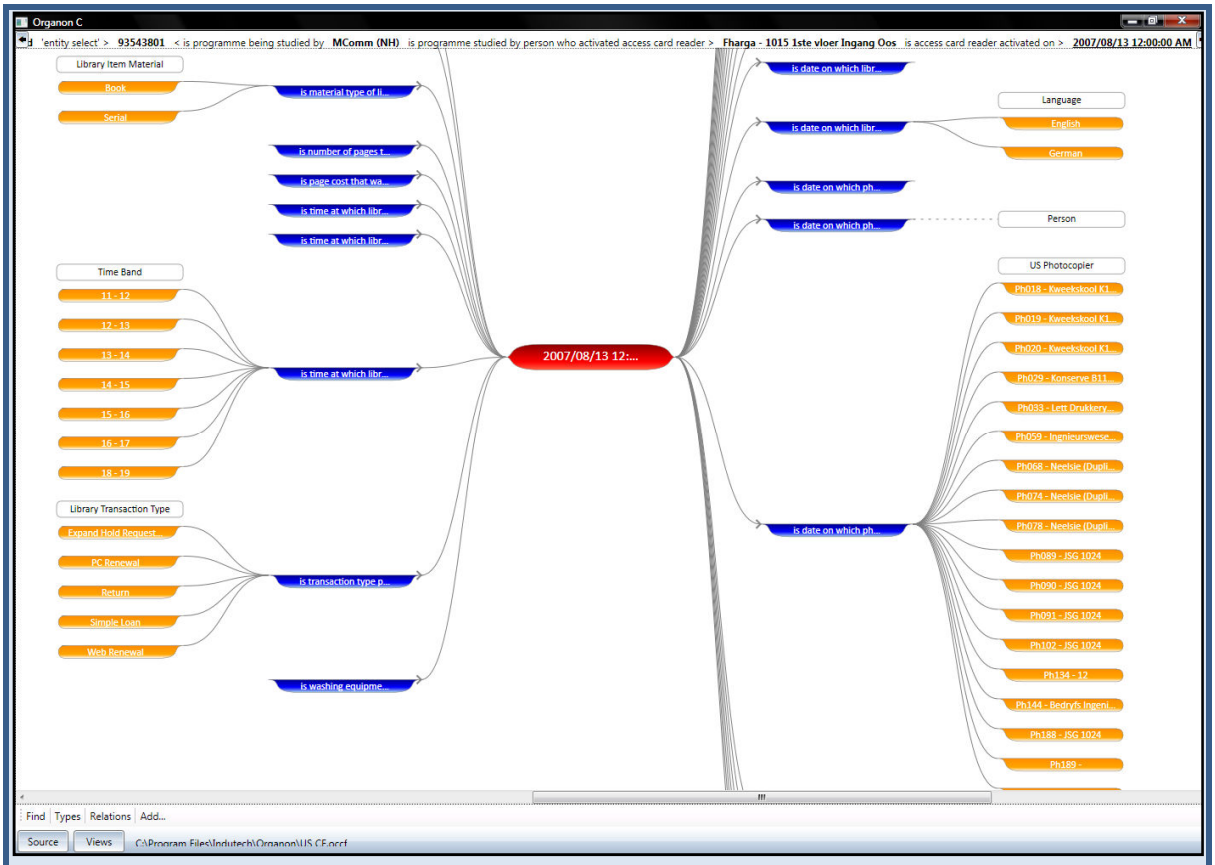


Figure 7.20: Screenshot 4 of Organon showing information of the SU IT conceptual framework implementation case study

Figure 7.20 shows a **"Date"** entity named "2007/08/13 12:00:00 AM", which provides a view of activities that occurred throughout the information domains in question on a specific date. Some of the relations that pertain to this entity are displayed, together with the following information:

- The types of library material on which library transactions were performed on this date
- The hours in which library transactions were performed on this date
- The types of library transactions that were performed on this date
- The languages of the library items on which transactions were performed on this date
- The photocopiers that were used on this date

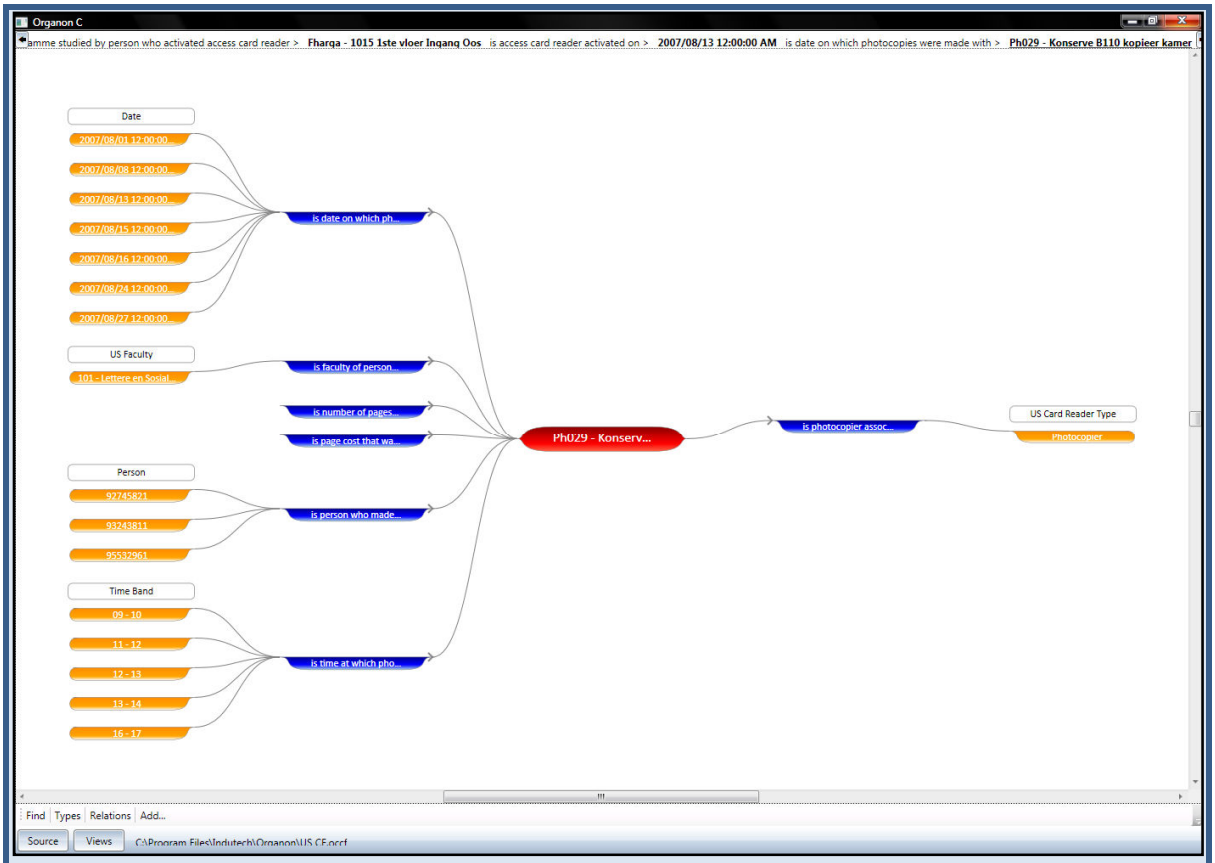


Figure 7.21: Screenshot 5 of Organon showing information of the SU IT conceptual framework implementation case study

Figure 7.21 shows a **"US Photocopier"** entity named "Ph029 Konserv B110 kopieer kamer" (or Ph029 Conservatory B110 copying room, which is one of the photocopying machines used on the date 2007/08/13, discussed in the previous screenshot), together with some of the relations that pertain to this entity. The following information relating to this particular photocopier is also provided:

- The dates on which this photocopying machine was used
- The faculty with which the persons who used the photocopying machine are enrolled
- The persons who used the photocopying machine
- The times at which the photocopying machine was used
- The type of card reader associated with the photocopying machine

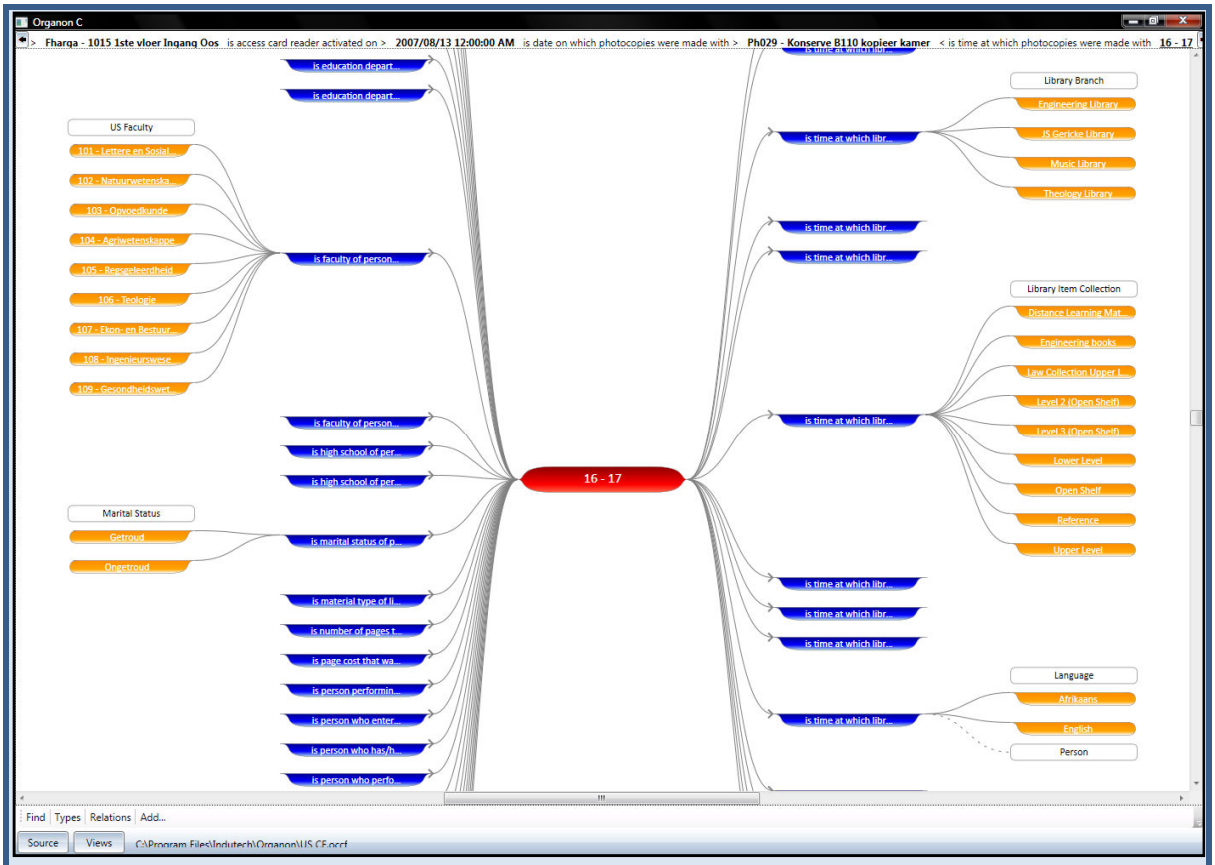


Figure 7.22: Screenshot 6 of Organon showing information of the SU IT conceptual framework implementation case study

Figure 7.22 shows a **"Time band"** entity "16 - 17" (which is one of the time bands in which photocopier "Ph029 Konserv B110 kopieer kamer" is used, discussed in the previous screenshot), together with some of the relations pertaining to this entity. The following information relating to this particular hour in a day is also provided:

- The faculties with whom persons are enrolled who activated access card readers in this particular time band
- The marital statuses of persons who performed library transactions in this particular time band
- The library branches at which library transactions were performed in this particular time band
- The collections within the university library system to which the library items belong on which library transactions were performed in this particular time band
- The languages of the library items on which library transactions were performed in this particular time band

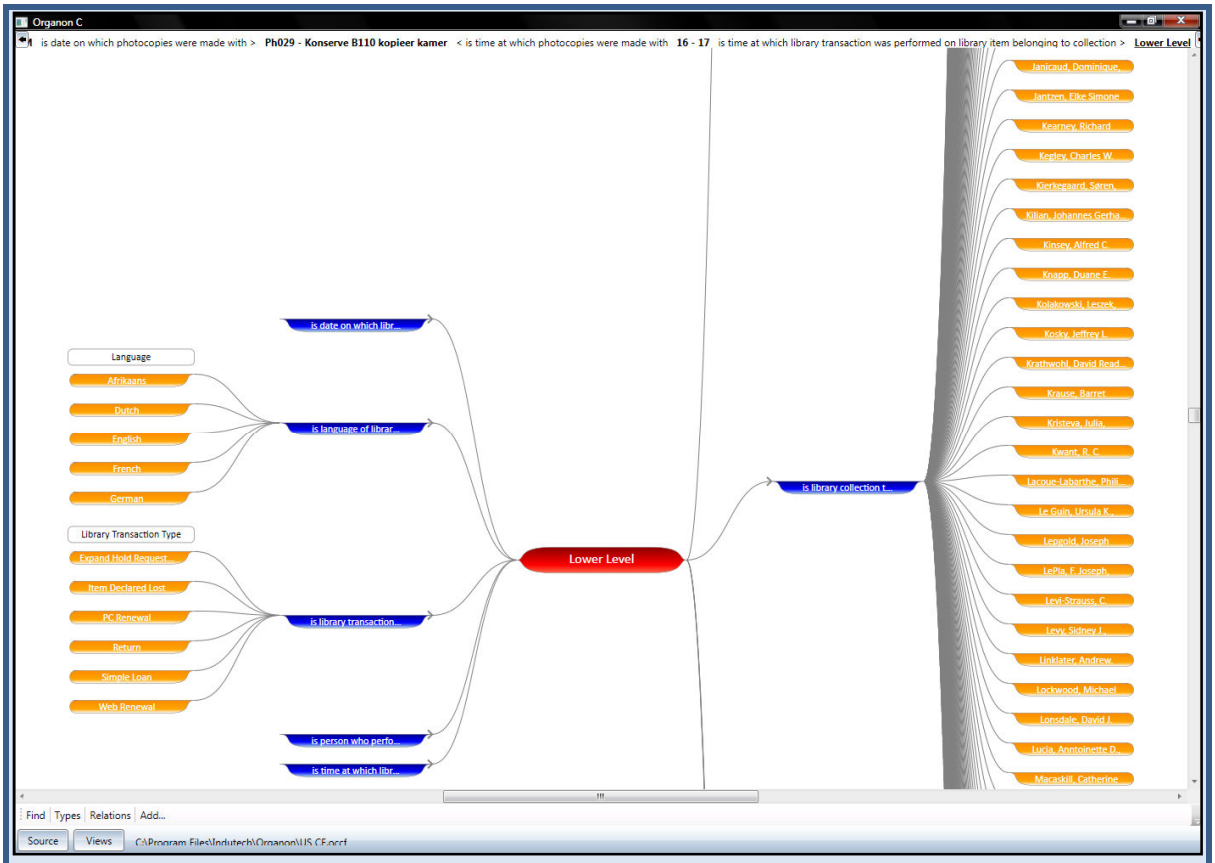


Figure 7.23: Screenshot 7 of Organon showing information of the SU IT conceptual framework implementation case study

Figure 7.23 shows a **"Library Item Collection"** entity "Lower Level" (which is one of the library collections of library items that have had library transactions performed on them in the 16 – 17 time band, discussed in the previous screenshot), as well as some of the relations pertaining to this entity. The following information relating to this library item collection is also provided:

- The languages of the library items belonging to this library item collection
- The types of library transaction performed on items from this library item collection
- The authors of the library items that belong to this library item collection

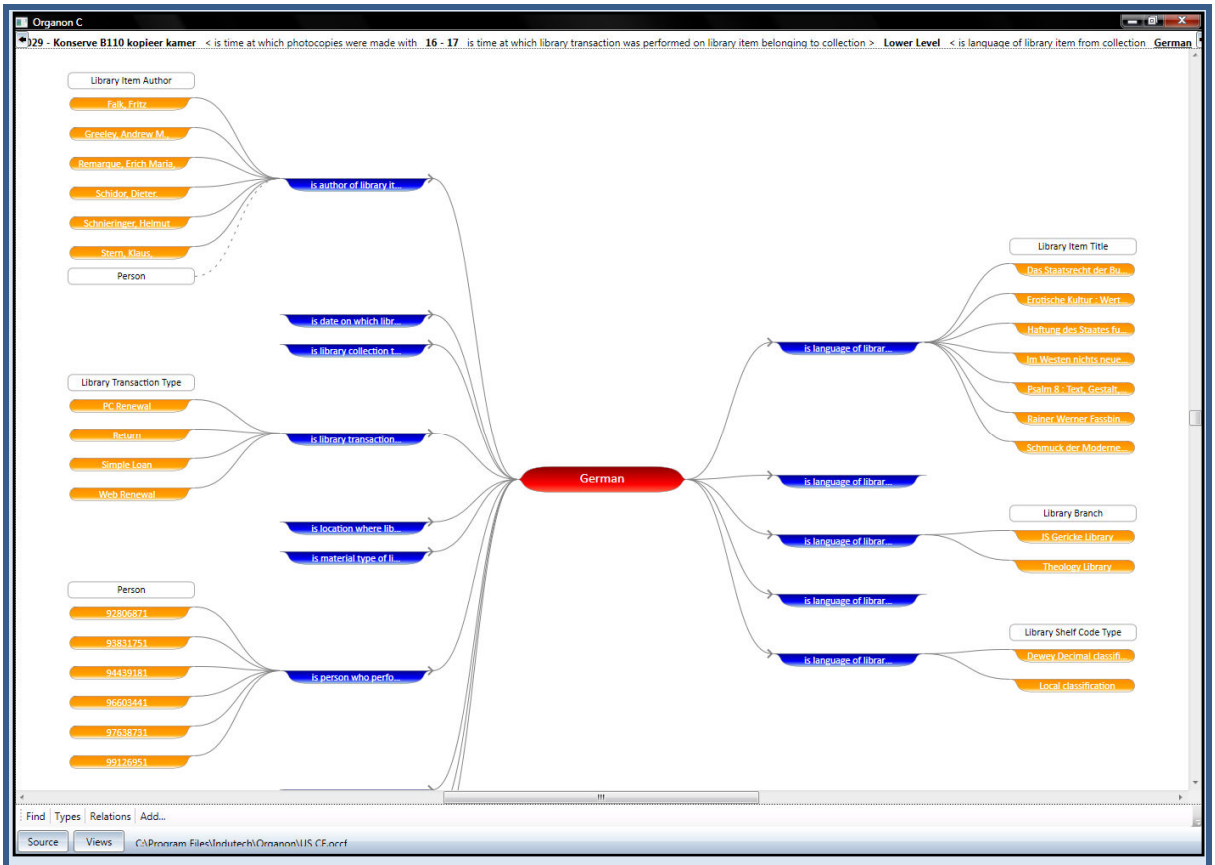


Figure 7.24: Screenshot 8 of Organon showing information of the SU IT conceptual framework implementation case study

Figure 7.24 shows a **"Language"** entity "German" (which can denote either the home language of a person, or the language a library item was written in, and is one of the languages of the library items in the "Lower Level" library collection, discussed in the previous screenshot), as well as some of the relations pertaining to this entity. The following information relating to this language is also provided:

- The names of authors of library items who was written in this specific language
- The types of transactions performed on library items written in this specific language
- The persons who have performed library transactions on library items written in this specific language
- The titles of library items written in this specific language
- The library branches where library transactions have been performed on library items written in this language
- The type of shelf codes used in the shelving of library items written in this language

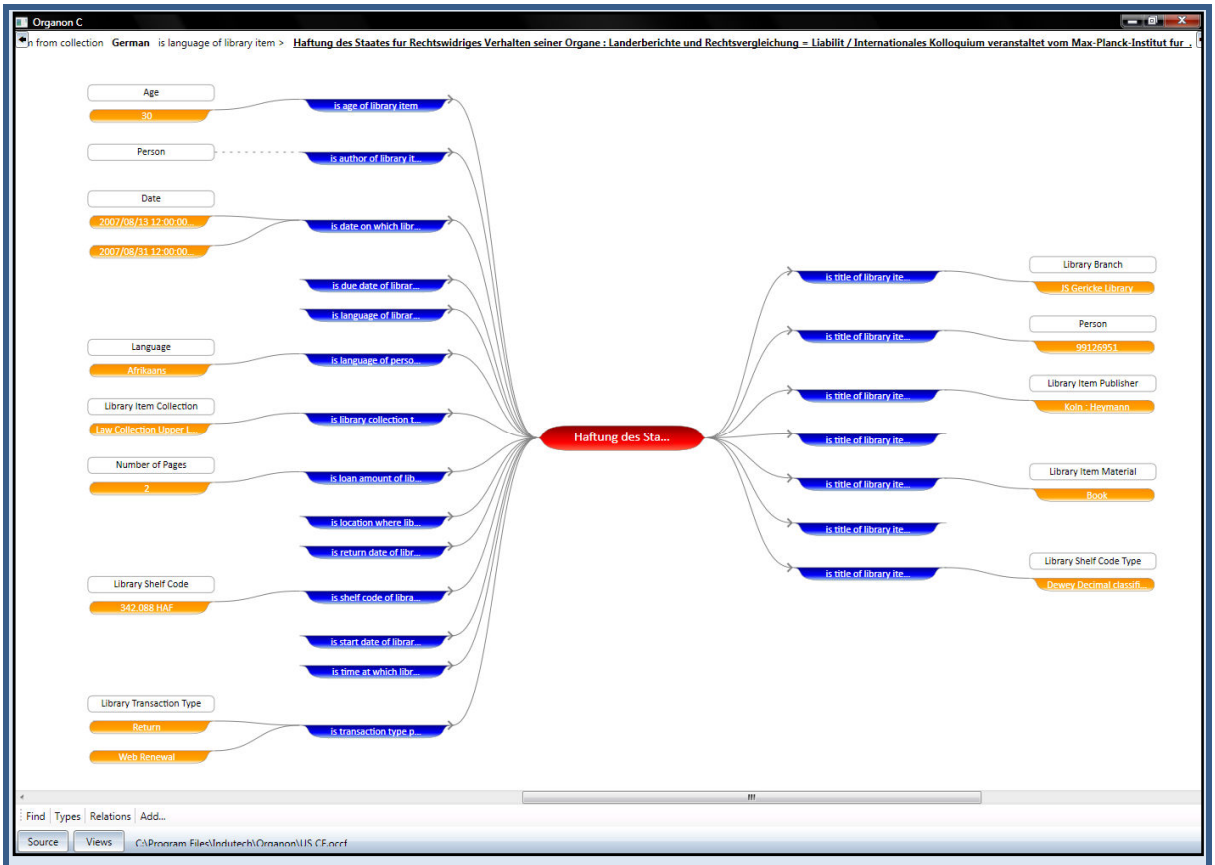


Figure 7.25: Screenshot 9 of Organon showing information of the SU IT conceptual framework implementation case study

Figure 7.25 shows a **"Library Item Title"** entity "Haftung des Staates fur Rechtswidriges Verhalter seiner Organe: Landerberichte und Reghtsvergleichung = Liabilit" (which represents the item itself, and is one of the library items written in the "German" language, discussed in the previous screenshot), as well as some of the relations pertaining to this entity. The following information relating to this library item is also provided:

- The age of this particular library item
- The dates on which library transactions were performed on this particular library item
- The languages of the persons who have performed library transactions on this particular library item
- The library collection to which this particular library item belongs
- The loan amount of this particular library item
- The library shelf code of this particular library item
- The types of library transactions that were performed on this particular library item
- The library branch where this particular library item can be found
- The persons who have performed library transactions on this particular library item
- The publisher of this particular library item
- The material type of this particular library item
- The shelf code type used in the shelving of this particular library item

Conceptual framework implementation methodology

Again it was highlighted that the decision to omit the initial information needs identification activity during the Planning phase of the conceptual framework methodology resulted in the approach lacking some focus, and therefore lacking usefulness for its users. It therefore gave a definite indication of the importance of this activity, as well as that the focus should also be defined with the intended users in mind.

Benefits of the SU IT conceptual framework

It was felt that the graphical representation of data can greatly improve the analytical capabilities of a user, especially if more business intelligence functionality can be present in the conceptual framework software tool used to visualise the conceptual framework. Furthermore, it has been noted that the conceptual framework can become very useful in specifically the university's library environment for tracking the behaviour of library patrons (e.g. their movements, active hours during the day, types of library material used by students from different subject disciplines, etc.) in order to plan the layout of the library to best service these patrons.

Shortcomings of the SU IT conceptual framework

No real shortcomings of the SU IT conceptual framework were identified, except for the fact that the absence of filtering and aggregation mechanisms makes it difficult for a user to interact with the masses information contained by the conceptual framework. This is however a shortcoming of the conceptual framework software tool, and not of the conceptual framework itself. The lack of focus in the SU IT conceptual framework that were experienced by the conceptual framework verification participants can obviously also be seen as a shortcoming.

Growing the SU IT conceptual framework

It was mentioned that adding administrative data of the university to the data currently represented by the SU IT conceptual framework, would provide a link between two traditional disparate information domains within the university (that is, between administrative and academic data), and would provide decision makers with a much more complete view to the university IT environment, and the manner in which persons interact with it. It was furthermore also noted that by providing additional information on the entities and relations defined in the original three information domains (like frequencies, totals, percentages, the significance of relations, etc.) an increase would be experienced in the value of the information represented by the conceptual framework.

Other observations

In general the conceptual framework verification participants (and especially the implementation stakeholders) found the conceptual framework approach to view organisational information quite useful, and its potential of connecting real-world transaction data (as a proxy for behaviour) to other structured data (such as surveys, results, and demographics) in the field of student tracking rather interesting. The overall feeling was that, with added reporting and business intelligence functionality, the conceptual framework approach could prove to be very useful in decision making within the organisation, as it succeeds in bringing (often) hidden information to light, thereby providing a much clearer view on the context of a certain matter, which should increase the overall quality of decision-making. Except for the fact that the final developed conceptual framework lacked focus because of the initial needs identification activity not having been performed, the Stellenbosch University: Information Technology conceptual framework implementation was deemed a success.

• *Conclusion – Stellenbosch University: Information Technology case study*

The SU IT conceptual framework implementation was seen as a success, and through the case study a number of conclusions could be made:

- Similar to the Indutech conceptual framework implementation case study, it was seen that by employing the conceptual framework implementation methodology discussed in this thesis, a conceptual framework of organisational information can successfully be created and implemented in the organisation.
- Organisational participants in the implementation could attest to the usefulness of the conceptual framework approach in representing organisational information, especially with regards to locating specific information and improving the quality of organisational decision making.
- It is imperative that the initial information needs identification activity is performed at the start of a conceptual framework implementation (during the Planning phase). If this activity is omitted, the risk exists that a conceptual framework is created that does not fully address the contexts of its intended target users, which will have a negative impact on its usefulness to them.
- Although a conceptual framework in itself can provide useful information to users within the organisation, its benefit will become much more relevant to decision makers should the

Chapter 8 – Conclusion

8.1 Introduction

As indicated by the illustration below (Figure 8.1), this chapter will conclude this document by giving a summary of the thesis content, and ending with a discussion of the hypothesis test results, and some finishing remarks.

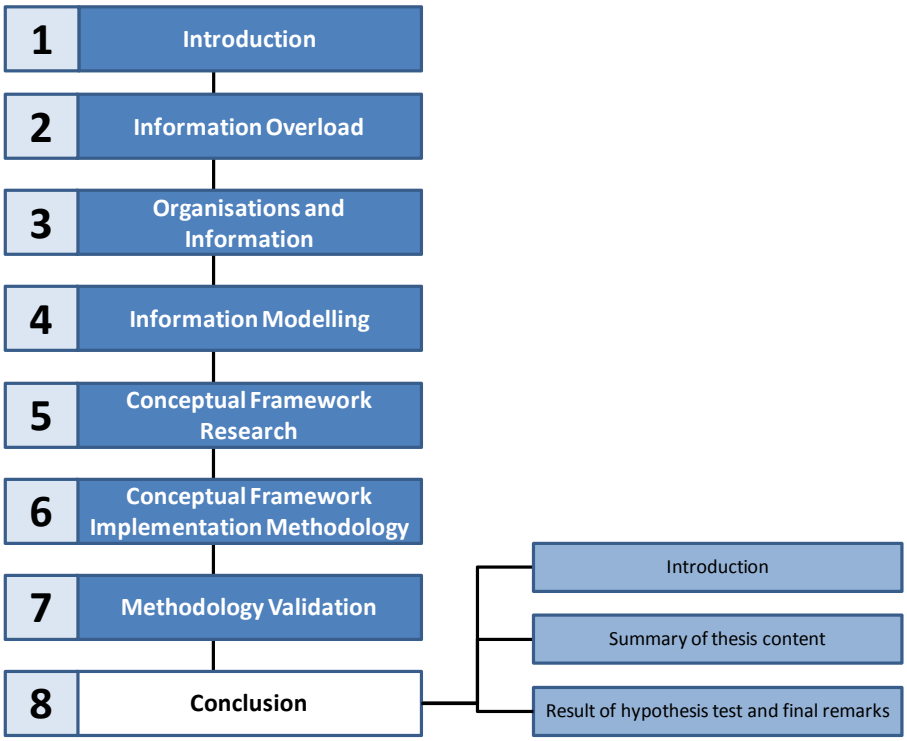
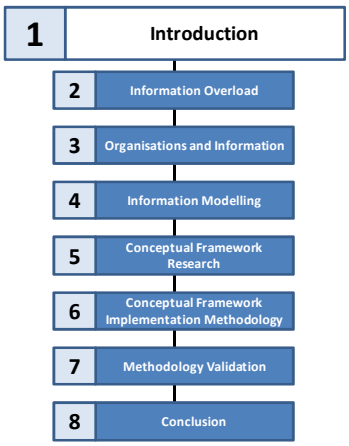


Figure 8.1: Image for navigating thesis and chapter 8

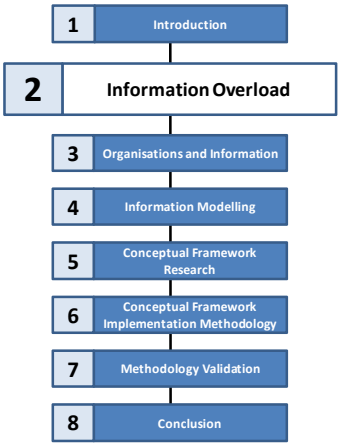
8.2 Summary of thesis content



Chapter 1 introduced this thesis by explaining how humanity's activities have shifted over the centuries from being survival-focused to being knowledge-focused, and that the masses of information that have been generated (and are still being generated) have become too much for people to process on their own.

It continued by noting that various tools and approaches have been developed to assist persons in the processing and application of information, but that these tools and approaches often fail to take into consideration the context in which a person might find him/herself, which then may result in the person's information need not being sufficiently addressed.

The chapter then introduced the rationale for the research project on which this thesis reports, which is the development of a methodology to facilitate the implementation of a context-sensitive information management approach in organisations. In order, however, to gain a better understanding of the environment and context for which this information management approach and implementation methodology was developed, a literature study was performed focusing on the concept of information overload, the manner in which organisations typically utilise and interact with information, and existing information modelling approaches, aimed at improving human-information interaction (Chapters 2 - 4).

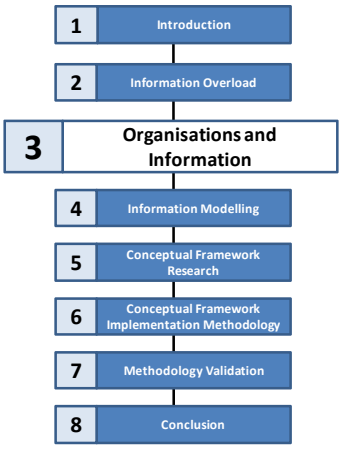


Chapter 2 focused on the topic of information overload, and started with considering the amounts of information currently available in the world, together with the rate that new information is being generated. It was indicated that these amounts of information, together with the fact that large variations are apparent in the quality of information being generated, make it difficult for a person to locate specific information in a short time, which may lead to the "condition" called information overload.

Information overload was then defined as being the provision of information in excess of the cognitive and emotional ability of an individual to process that information, and it was explained how the performance of a person will improve with an increase of information up to a certain point, from where it will again start to decrease as the person fails to assimilate amounts of information in excess of his/her capabilities. The manner in which this effect is experienced in an even more pronounced fashion in organisations, was also discussed.

Finally, the different causes and symptoms of information overload were discussed, together with different solutions proposed by experts in the information overload research field. Special mention was made of the following possible solutions to information overload, as they were very relevant to the theme of this thesis:

- Delivering the information in the most convenient way and format;
- Visualisation, compression and aggregation of the information;
- Using methods of intelligent information management for easier information prioritisation; and
- Using quality filters.

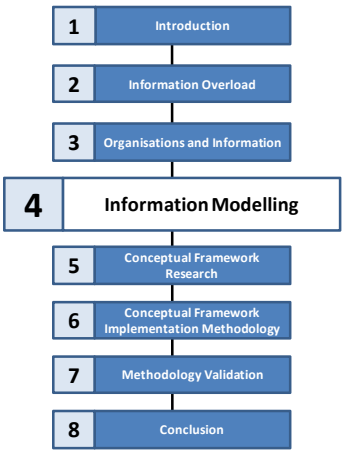


Chapter 3 discussed the manner in which organisations make use of information, and started by explaining the relevance of information to organisations. It also explained that, besides enabling an organisation to orientate itself within its environment, it enables the organisation to continuously increase its knowledge about itself. Different aspects of the manner in which organisational information utilisation takes place were discussed, particularly information as documents and transactions, information silos and integrated information, and information management tools and approaches typically employed by organisations.

The chapter furthermore proceeded to discuss in general the shortcomings of the manner in which organisations typically utilise information, but also mentioned various solutions that have been developed and implemented (with various levels of success) to address these shortcomings.

The chapter concludes by suggesting that the large variation in the tools and approaches aimed at providing effective information management capabilities to organisations may be an indication that the nature of information is still not sufficiently understood to effectively address this problem. A suggestion is made that the notion of considering information as a collection of atomic points of data which are related to each other in some manner might provide a way for persons in an organisation to interact much easier with information. This “modelling of information” was then discussed in the next chapter.

Chapter 4 focused on the concept of information modelling, and discussed the concepts behind a number of information modelling approaches currently used throughout the world, aimed at assisting persons in their interaction with information. The contexts and manners in which these approaches are typically applied were also discussed.

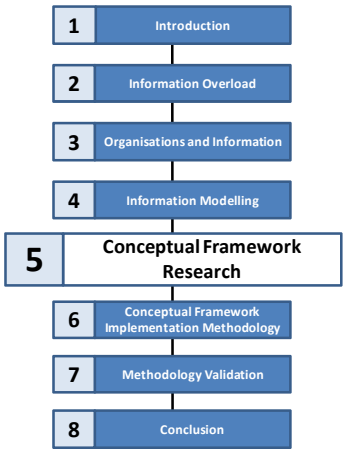


The discussion focused on the following approaches:

- Semantic networks;

- Thesauri;
- Taxonomies;
- Ontologies;
- Folksonomies;
- Concept maps; and
- Topic maps;

At the end of this chapter the approaches discussed were compared, based on the generality, flexibility and simplicity of each approach (as these features were deemed critical for an approach that provides an improved general human interaction with information). It was found that, from the approaches discussed, none could address all three features satisfactorily. The statement was made that a need still exists for an information representation technique which can be easily understood by most information users, whilst still providing enough functionality to address information modelling requirements over a broad spectrum of application. This led to the introduction of the conceptual framework approach discussed in Chapter 5.



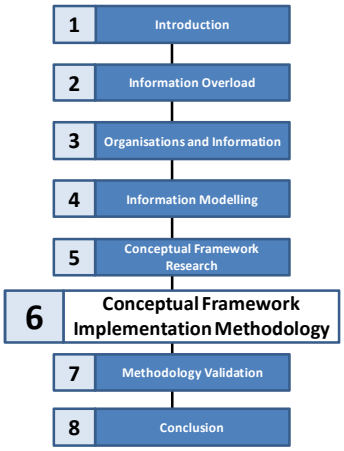
Chapter 5 introduced the concept of a conceptual framework, and explained its definition, together with the fact that the construction of a conceptual framework is based on only four concepts, namely that of entities, relations, facts and types (each of which were also explained).

The conceptual framework approach was compared with the information approaches discussed in the previous chapter, explaining the manners in which these approaches differ from the conceptual framework approach. It was further indicated that conceptual frameworks can be applied to both structured and unstructured information, and that it lends itself very well to the graphical representation of information (which is normally useful from a users' perspective).

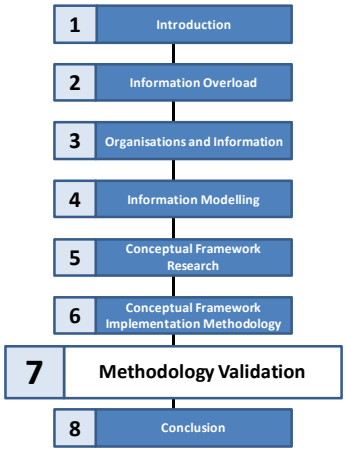
The chapter proceeded to provide more information on research into conceptual frameworks, most notably the two streams of research focusing on employing the conceptual approach in the representation of structured information and unstructured information. It further indicated that the research described in this thesis makes up part of the research stream focusing on structured information.

The chapter concludes by providing the hypothesis of this thesis, and the research method that was followed.

Chapter 6 provided the conceptual framework implementation methodology that was developed through the research on which this thesis reports. The methodology is composed of five phases, each with a number of activities that should be executed to successfully implement a conceptual framework in an organisation. The structure of the methodology is as follows:



- **A – Planning phase**
  - *Activity A1 – Identify stakeholders*
  - *Activity A2 – Initial information need identification*
- **B – Analysis phase**
  - *Activity B1 – Examination of information sources pertaining to stakeholder-specified information requirements*
  - *Activity B2 – Development of conceptual framework specification*
- **C – Development phase**
  - *Activity C1 – Fulfil conceptual framework hardware requirements*
  - *Activity C2 – Create and populate conceptual framework*
  - *Activity C3 – Verify information represented by conceptual framework*
- **D – Implementation phase**
  - *Activity D1 – Information infrastructure setup*
  - *Activity D2 – User setup*
- **E – Maintenance phase**
  - *Activity E1 – Grow conceptual framework*



Chapter 7 discussed the validation of the conceptual framework implementation methodology, discussed in the previous chapter.

Validation of the methodology was done in two ways. First, the methodology was validated from a theoretical point of view through comparison with existing implementation methodologies which facilitate the implementation of other types of information modelling approaches (like ontologies) in organisations. The aspects addressed by the conceptual framework implementation methodology was found to correspond very well with the aspects focused upon by the other approaches, and thus the conceptual framework implementation methodology was validated (from a theoretical point of view).

The second manner in which the conceptual framework was validated, was through the execution of two conceptual framework implementation case studies, through which conceptual frameworks were implemented in two actual organisations. Feedback from the stakeholders and participants of each of the

implementations affirmed that the conceptual frameworks were successfully implemented, and that the information represented by each conceptual framework gave an accurate view on the organisational information involved. Through the case studies the conceptual framework implementation methodology was therefore validated from a practical point of view, which released the methodology for wide-spread application.

Chapter 8 has provided a summary of the contents of this thesis, and will now continue to discuss the result of the hypothesis test, following with some final remarks.

8.3 Result of hypothesis test and final remarks

8.3.1 Hypothesis Test

In section 5.3 the following hypothesis (which this thesis aimed to prove or disprove) was stated:

Hypothesis: **Information represented by a conceptual framework implemented through the use of the developed conceptual framework implementation methodology, offer a truthful view on information found in an organisation.**

The only mechanism through which this hypothesis could be tested was through the conducting of actual conceptual framework implementations and assessing whether the information represented by each resultant conceptual framework mirrors the organisational information on which the implementation focused. As already discussed, such implementations were performed at a small industrial engineering organisation called Indutech (Pty) Ltd., and at the Information Technology division of Stellenbosch University (see sections 7.3.2 and 7.3.3). As part of the conceptual framework implementation methodology followed in both cases, stakeholders of each implementation were

required to verify the accuracy of their specific conceptual framework as thoroughly as possible. Because these verifications addressed exactly the same issue that the hypothesis mentioned above focuses on, the conclusions from these verifications could be directly applied in the hypothesis test.

Both sets of stake holders agreed that, based on their exposure to the conceptual framework that was developed through the implementation case study in which they took part, a conceptual framework developed by means of the conceptual framework implementation methodology discussed in this thesis offer a truthful view on organisational information. It can therefore be said that the hypothesis could not be disproven, and can therefore be assumed to be true. There are however two aspects of the implementations that should be clarified in order for this conclusion to have credibility:

- Stakeholders were not able to thoroughly analyse the information constituting each of the conceptual frameworks. This should however have no real effect on the outcome of the hypothesis test as the conceptual frameworks were constructed in a consistent manner, and the conceptual framework information that were not analysed by the stakeholders should therefore (from a conceptual point of view) be no different from the conceptual framework information that were.
- In neither of the two implementations were all the phases of the conceptual framework implementation methodology that were discussed in this thesis executed. As was mentioned in section 7.4, the Implementation and Maintenance phases of the conceptual framework implementation methodology were not executed in either of the two implementation case studies. This did however not have any impact on the outcome of the hypothesis test as these phases, though very relevant and important in the process of implementing conceptual frameworks, focus on activities that should take place *after* the organisational conceptual framework have been created and verified.

The hypothesis, which forms the main focus of this thesis, could therefore not be disproven, and can consequently be assumed to be true. It can thus be confidently stated that:

Information represented by a conceptual framework implemented through the use of the developed conceptual framework implementation methodology, offer a truthful view on information found in an organisation.

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Mind maps and concept maps have gained popularity during the past few years as handy tools for structuring ideas before focusing on detail. These maps consist of a root topic and several lower-order topics - in essence representing a tree of topics or concepts. Usually, each topic can be explained with an associated note, while relations between related topics can also be drawn; it is even possible to attach binary files to a topic using some editors.

Although mind maps are excellent tools for structuring ideas around a certain topic, they are somewhat limiting when it comes to representing more complex environments consisting of several topics with explicit and implicit relations among them. In order to adequately represent such an environment, a network structure - consisting of entities and relations - is required.

Organon was developed as a tool to help its users to structure unstructured, qualitative problems to gain an understanding of the problem without losing the context of the detailed elements of the entities in the makeup of the problem. The network structures that can be created, explored and edited using Organon are called conceptual frameworks. Using Organon, various users can explore the conceptual framework (CF) of a certain environment, starting from an entity known to them, and reaching related, unknown entities by clicking on self-explanatory relations gaining an understanding of the environment as they go along. Users can further expand the CF by adding new entities or by associating existing entities - using new or existing relations - adding their own understanding to the CF while doing so.

A simple example illustrating the value of a CF is presented overleaf.

Organon has the following features:

- Explore the CF - by clicking on entities and associated relations - to gain an understanding of the environment represented.
- Expand the CF by relating existing entities to new entities using existing or new relations.
- Search for all entities matching a given string and start exploring the CF from any entity in the result set.
- Find how two sets of entities are connected in the CF.
- Build a tree view starting at a given entity and expanding on specified relations.
- Create templates for frequently used entities to speed up the process of expanding the CF.
- Get more information about a given entity in one click by using the Lookup on Google or Lookup on Wikipedia commands.

It will shortly be possible to link CF entities to actual text in electronic documents to provide an additional dimension to the context of an entity.

SHOULD YOU REQUIRE MORE INFORMATION ABOUT ORGANON, PLEASE CONTACT US AT INFO@INDUTECH.CO.ZA.

ORGANON

CONCEPTUAL FRAMEWORK EXAMPLE

Suppose one wants to create a conceptual model of a manufacturing company to serve as a mechanism to capture the various complexities involved in the relevant environment with the aim to gain a better understanding of the environment among the employees to generate ideas for possible simplifications.

One may then identify certain generic entity types that would form part of the model (e.g. departments, employees, products, raw materials, manufacturing equipment, suppliers, etc.) as well as initial relations applying among the entity types identified.

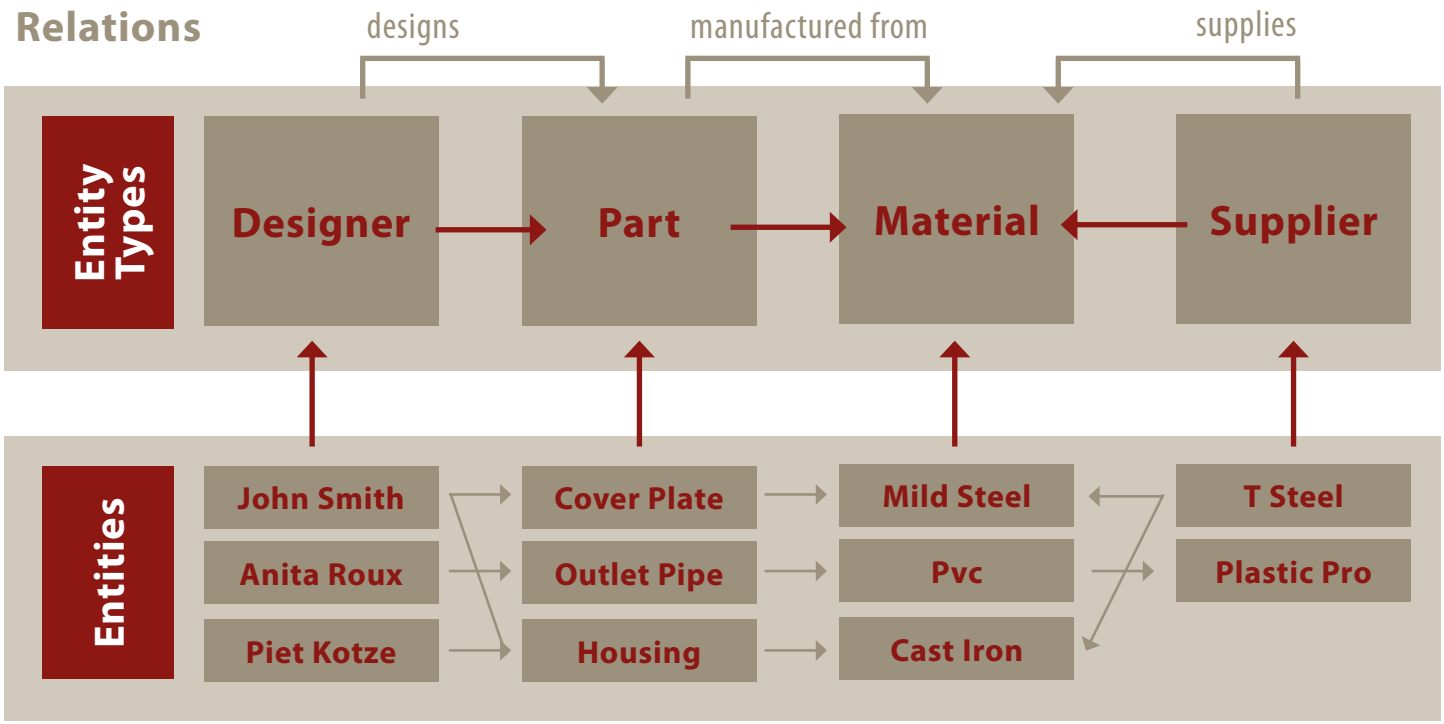
The network resulting from the combination of entity types and accompanying relations is called a Conceptual Framework (CF). Any entity [type] - relation - entity [type] pair is called a fact (e.g. 'Part manufactured from Material' or 'John Smit is a Designer' where 'Part' and 'Material' are entity types, 'manufactured from' and 'is a' are relations and 'John Smit' is a entity).

Typically, several departments will be involved in the construction of the CF, e.g. the HR department will add all employee information, the Procurement department will specify all suppliers and materials, whereas the Production department will add all products, machines, etc. Each party involved expands the CF with his/her view providing more information, context and dependencies.

For example, the Production department may add the entity type 'Manufacturing Processes' to capture which processes are used to produce which products; the same department may also associate certain materials with certain products and manufacturing processes - building on the information (i.e. the various materials) added by the Procurement department.

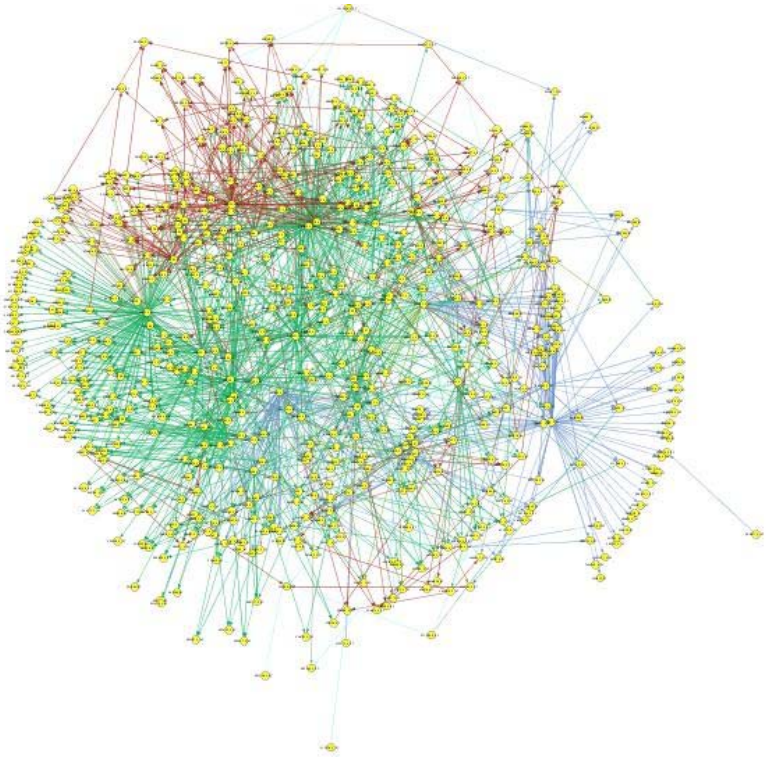
Using the CF, the Procurement department can now learn what the various materials they order everyday are used for in terms of products and processes, just as the Production department can learn from whom they receive the various materials used in the production of the various products.

The CF can therefore be used to understand the manufacturing environment as a whole, as well as the interactions between the various entities that make up the environment.



Conceptual Framework Implementation

Documentation



Planning and Analysis

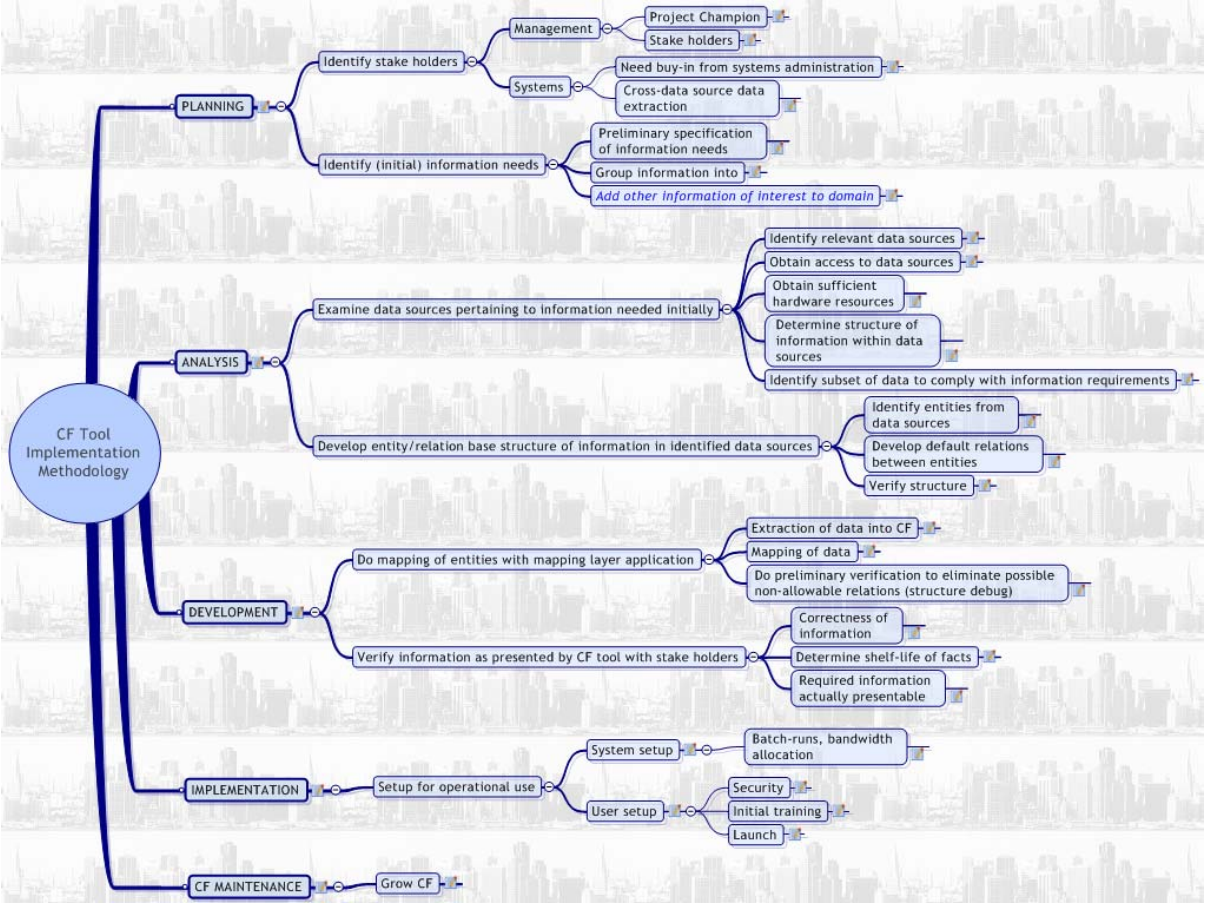
Document

Implementation: **Case Study - University Of Stellenbosch**

Date: **9 September 2007**

Author: **Dirk Kotze**

Methodology



This document contains outputs from the PLANNING step of the Conceptual Framework Tool Implementation Methodology.

Reason for the project

The project is conducted primarily as a research case study by the Industrial Engineering Department of the University of Stellenbosch and Indutech (Pty) Ltd. for testing an implementation methodology developed for establishing a Conceptual Framework approach for the utilising of institutionalised information in an organisation. A secondary reason for the case study is to get a feeling for whether the particular organisation finds the information portrayed by the Conceptual Framework, as well is the manner in which it is portrayed, useful for decision making and whether the ease of locating specific information has been improved. The Information Technology department of the University of Stellenbosch has tentatively agreed to the case study in order to have a fresh look on the

information in its possession, as well as assisting in furthering the scientific prowess of the University of Stellenbosch.

Stakeholders

This section identifies the stakeholders of the Conceptual Framework implementation process.

Principal Stakeholder:

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Domain of interest

The domain to be mapped is aimed at studying the impact that users at the university (both students and personnel) have on the university's information infrastructure. Sub-domains to be included in the project are:

- Card reader transaction information
- Demographic and study programme information
- Internet usage cost information
- Library transaction and item information
- Printing transaction information
- WebCT usage information

The US Conceptual Framework - Entities

Through a study made of the domain to be mapped (including the sub-domains listed in the previous section), the following entities have been identified:

Entity Name	Description
Age	Age of a US[1] student or a library item.
Date	Any references made to dates in the US IT[2] environment being mapped. This include the following: • Dates of card reader transactions; • Dates of internet transactions; • Dates of library transactions; • Dates of printing transactions; and • Dates of WebCT actions.
Document Type	Types of documents, e.g. MS Word documents, MS Excel documents, PDF documents, etc. (mainly related to printing operations).
Education department	Denoting a South African education department, from which a scholar can receive a senior certificate used in applying for study at the US.
File Size	Byte size of a computer file (mainly related to printing operations).
Gender	Male/Female.
Handicap	Manner of handicap experienced by a US student (this includes wheelchair handicap).
High school	High school attended by a US student.
Language	Language spoken by a US student.
Library Branch	Branch of the US library services where items can be loaned to students.
Library Database Name	Name of an on-line information database managed by the US library, and which can be accessed by students through a web-portal.
Library Dewey Classification	Number of a library item corresponding to a numbering system utilised by the US library to categorise its items.
Library Item Author	Author of a library item.
Library Item Collection	Indication of the type of US library material (e.g. reference material).

[1] University of Stellenbosch
[2] Information Technology

Entity Name	Description
Library Item Loan Amount	Amount of times library items have been loaned out.
Library Item Material	Media format of a US library item.
Library Item Publisher	Publisher of a US library item.
Library Item Status	Status of a US library item.
Library Item Subject Topic	Broad topic that includes a specific US library item.
Library Item Title	Title of a US library item.
Library Item Vendor	Vendor of a US library item.
Library Shelf Code	Shelf code where a US library item is stored.
Library Shelf Code Type	Distinguishes between different shelf code systems used by the US library.
Library Transaction Location	Indicates whether a US library transaction was conducted at the counter in the library, or through a web portal.
Library Transaction Patron Type	Type of person performing a certain transaction at the US library.
Library Transaction Type	Type of transaction performed at the US library.
Marital status	Marital status of a US student.
Nationality	Nationality of a US student.
Network traffic	Network usage experienced by US IT systems (mainly indicates internet usage and usage of US library on-line information sources in bytes per hour).
Number of pages	Number of pages used through printing and photo-copying activities.
Page Cost	Page cost of printing and photocopying activities.
Person	User of the US IT system, accessing the system through UT number or computer username. This includes the usage of card readers, internet access, printing and library services and WebCT. It further provides access to academic and demographic information stored by US on its students.
Population group	Population group of a US student.
Postal code	Postal code of US student.

Entity Name	Description
Time band	Any references to time made in the US IT system, grouped in time bands. This include the following: • Times of card reader transactions; • Times of internet transactions; • Times of library transactions; • Times of printing transactions; and • Times of WebCT actions.
Town	Home town of US students as well as cities where certain publishers of US library items are situated.
US Campus	Indicates one of the three main US campuses: Stellenbosch, US Business School and Saldanha Military Academy.
US Card Reader	Name of a US card reader.
US Card Reader Type	Indicating type of US card reader (e.g. door access, photo copier, washing equipment, etc.)
US Department	Department of the US.
US Faculty	Faculty of the US.
US Module	Module (or subject) taken by US student and presented by a US department.
US Photocopier	Name of a US photocopier.
US Printer	Name of a US printer.
US Programme	Name of a programme presented by the US.
US Programme Continuity	Indicates whether a programme is studied full-time or part-time.
US Qualification	Type of US qualification that can be attained by a student, e.g. degree, diploma, certificate, etc.
US Residence	Name of a US residence. Only applicable to the usage of card readers with regards to washing equipment.
US Residence Type	Indicates a type of US residence, e.g. hostel, student house, etc.
US Vehicle license plate	License plate number of US vehicles in the US motor pool.
US Washing Equipment	Type of US washing equipment that can be used by US students, e.g. washing machine, tumble drier, etc.

Entity Name	Description
US Workstation/PC	Name of a US workstation or PC used for printing of documents and internet access.
WebCT Action	Action performed by a user in the US WebCT environment.
WebCT Dwell time	Time spent by a user in the US WebCT environment between actions.
WebCT Event Role	Role of a user when performing an action in the WebCT environment.
WebCT Learning Context	Learning context in the WebCT environment.
WebCT Learning Context Administrative Period	Period for which a specific WebCT learning context is accessible.
WebCT Learning Context Role	The role of a user in a specific learning context.
WebCT Learning Context Type	Indicates the level where a learning context can be found in the WebCT environment.
WebCT Number	Any references to numbers in the WebCT environment, usually used in reporting the contents of WebCT templates and WebCT learning contexts.
WebCT Organization	Name of organisation using specific WebCT learning contexts.
WebCT Organization Type	Value distinguishing general categories of the organisation.
WebCT Organization Unit	Name of sponsoring/administering unit within the organisation.
WebCT Size	Any references to sizes in the WebCT environment, usually used in reporting the file sizes.
WebCT Template	Component of WebCT learning context that can be utilised by users.

The US Conceptual Framework – Relations

Different types of relations can be defined between the various entities listed in the previous section. The relation types which will be used in this mapping are **basic**, **inferred** and **aggregation** relations.