Improving Reference Selection Within Bid Processes

A Master Thesis Within The Sales Department Of Capgemini Outsourcing

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Capgemini Outsourcing Netherlands

Master Industrial Engineering & Management
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Management summary

During the last global knowledge management meeting of Capgemini Outsourcing, several spearheads are determined to make the bid process more efficient and more effective. Reference selection is one of these spearheads. A reference is a description of services delivered to an existing customer. When a potential customer wants to outsource (parts of) his information technology, he asks for references that show that Capgemini owns the desired capabilities. Reference selection is the process of finding suitable references that satisfy the customer requirements.

In the past reference selection was done ad hoc: there is no procedure how to select appropriate references and no clear overview of the available references, so the selection depended entirely on the knowledge of the sales employees involved. Reference selection cost a lot of time and effort and often did not result in an optimal choice of references: often the references did not fully satisfy the customer demands.

During this graduation assignment a reference selection system based on case-based reasoning is designed and developed, that assists sales employees in selecting suitable references within bid processes. This Reference Tracking System improves both the efficiency and the effectiveness of the reference selection process.

The major conclusions of this graduation assignment are:

- The Reference Tracking System provides a single point of entry to references at diverse locations, which saves time and effort during the reference selection.
- The Reference Tracking System facilitates sales employees in selecting references, which leads to a better substantiated reference selection and reduces time and effort.
- This graduation research shows that case-based reasoning can improve knowledge selection processes.

The results of this research study lead to some practical recommendations for Capgemini and some suggestions for further research.

For Capgemini to fully grasp the benefits of the Reference Tracking System, this graduation assignment results in the following recommendations:

- Ensure that both the users and senior management support the Reference Tracking System. Users from all regions and disciplines of Capgemini should support the reference selection system to make it a success.
- Input from all regions and disciplines of Capgemini is needed to fill the reference library with all references available at Capgemini.
- Sufficient human as well as financial resources are necessary to further improve the Reference Tracking System and fill the reference library with all references available in the diverse regions and disciplines of Capgemini.
- A major improvement of the Reference Tracking System would be the inclusion of a keyword guide that assists the users in choosing keywords.

Future research should focus on:

- The impact of intelligent systems founded on case-based reasoning on the efficiency and effectiveness of knowledge selection in situations where the alternatives cannot be clearly defined and described.
- The impact of intelligent systems founded on case-based reasoning on the efficiency and effectiveness of knowledge selection in situations where the selection criteria are not unambiguous.
- The impact of other methodologies on the efficiency and effectiveness of knowledge selection.

This graduation research study has resulted in a prototype of an intelligent system that facilitates Capgemini's sales employees in selecting suitable references within bid processes. The prototype of the Reference Tracking System shows that an intelligent system founded on case-based reasoning can improve knowledge selection. However, continuous attention and effort are needed to create and maintain a reference selection system that improves the efficiency and effectiveness of the reference selection within bid processes.

Management samenvatting

Tijdens de laatste wereldwijde kennismanagement vergadering van Capgemini Outsourcing zijn er diverse speerpunten bepaald om aanbiedingsprocedures efficiënter en effectiever te maken. Één van deze speerpunten is referentieselectie. Een referentie is een beschrijving van diensten die geleverd worden aan een bestaande klant. Als een potentiële klant (delen van) zijn informatie technologie wil uitbesteden, dan vraagt deze om referenties die laten zijn dat Capgemini over de gewenste capaciteiten beschikt. Referentieselectie is het proces om geschikte referenties te vinden die voldoen aan de gestelde eisen.
In het verleden was er geen vaststaande procedure voor referentieselectie. Bovendien was er geen overzicht van de aanwezige referenties. Het resultaat van de selectie hing volledig af van de kennis van de betrokken salesmedewerkers. Referentieselectie kostte veel tijd en moeite en vaak resulteerde het niet in een optimale keuze van referenties: de referenties voldeden vaak niet volledig aan de eisen van de klant.
Tijdens deze afstudeerstage is er een referentieselectiesysteem ontworpen en ontwikkeld, dat gebaseerd is op case-based reasoning en salesmedewerkers assisteert bij het selecteren van geschikte referenties binnen aanbiedingstrajecten. Dit Reference Tracking System verbetert zowel de efficiëntie als de effectiviteit van het referentieselectieproces.

De belangrijkste conclusies van deze afstudeeropdracht zijn:

- Het Reference Tracking System biedt één ingang voor de salesmedewerker om eenvoudig referenties te bereiken die op diverse locaties staan. Dit bespaart tijd en moeite bij de referentieselectie.
- Het Reference Tracking System assisteert salesmedewerkers bij het selecteren van geschikte referenties. Dit leidt tot een beter beargumenteerde referentieselectie en ook dit bespaart tijd en moeite .
- Dit afstudeeronderzoek toont aan dat case-based reasoning geschikt is om kennisselectie processen te verbeteren.

De resultaten van deze onderzoeksopdracht leiden tot enkele praktische aanbevelingen voor Capgemini en enige suggesties voor verder onderzoek.
Capgemini dient de volgende aanbevelingen in acht te nemen voor het volledig benutten van het Reference Tracking System:

- Zorg voor draagvlak voor het Reference Tracking System bij zowel de gebruikers als het hogere management. Gebruikers vanuit alle regio's en disciplines van Capgemini moeten het systeem steunen om van het systeem een succes te maken.
- Inbreng vanuit alle regio's en disciplines van Capgemini is nodig om de referentiebibliotheek te vullen met alle referenties die aanwezig zijn binnen Capgemini.
- Voldoende menskracht en financiële middelen zijn nodig om het Reference Tracking System verder te verbeteren en om de referentiebibliotheek te vullen met alle referenties die aanwezig zijn binnen de diverse regio's en disciplines van Capgemini.

- Een belangrijke verbetering aan het Reference Tracking System zou de toevoeging van een trefwoordengids zijn, die gebruikers assisteert bij het kiezen van trefwoorden.

Verder onderzoek moet zich richten op:

- De gevolgen van intelligente systemen gebaseerd op case-based reasoning op de efficiëntie en de effectiviteit van kennisselectie in situaties waar de alternatieven niet duidelijk gedefinieerd en beschreven kunnen worden.
- De gevolgen van intelligente systemen gebaseerd op case-based reasoning op de efficiëntie en de effectiviteit van kennisselectie in situaties waar de selectiecriteria niet eenduidig zijn.
- De gevolgen van andere methodologieën op de efficiëntie en de effectiviteit van kennisselectie.

Deze afstudeeronderzoeksopdracht heeft geresulteerd in een prototype van een intelligent systeem dat Capgemini's salesmedewerkers ondersteunt bij het selecteren van geschikte referenties binnen aanbiedingsprocedures. Het prototype van het Reference Tracking Systeem toont aan dat een intelligent systeem gebaseerd op case-based reasoning kennisselectie kan verbeteren. Continue aandacht en inspanning zijn echter nodig om een referentieselectiesysteem te krijgen en te behouden, dat de efficiëntie en de effectiviteit van kennisselectie binnen aanbiedingstrajecten verbetert.

Table of contents

Table of illustrations

Figures

Tables

Glossary

Best and final offer (BAFO): a request sent out by a potential customer in which he demands final information about the required services. A BAFO is only part of large and complex tender trajectories and is the continuation of a RFP.

Bid process or bid trajectory: the tender process in which a vendor responses to a customer's request for information about certain services that the customer wants to subcontract.

Confidentiality level: to what extent a reference could be published and used. For a list of the different confidentiality levels and an explanation, see Appendix A.

Discipline: a key area of focus of Capgemini. For a list of the different disciplines, see Appendix A.

Hit rate: the match between the details of a reference and the search criteria inserted by the user expressed in percents.

Offer: a service line of Capgemini Outsourcing. For a list of the different offers, see Appendix A.

Reference: the description of certain services delivered to a referent.

Reference document: a document that contains a reference.

Reference library: the database consisting of all

Reference Tracking System (RTS): the intelligent system designed and developed during this graduation assignment. This system facilitates sales employees of Capgemini in selecting suitable references for bid processes.

Referent: a customer to which Capgemini delivers services.

Request: a RFI, RFP or BAFO.

Request for information (RFI): a request sent out by a potential customer in which he demands some basic information regarding the required services. A RFI is usually the first step in a bid trajectory.

Request for proposal (RFP): a request sent out by a potential customer in which he demands further information about the required services. A RFP is usually the second and last step in a bid trajectory.

Response: an answer to a RFI, RFP or BAFO.

Selection criterion: a search criterion inserted by the user that a suitable reference should satisfy.

Sub offer: a part of a service line of Capgemini Outsourcing. For a list of the different sub offers, see Appendix A.

Preface

This Master thesis is the closure of my Master's Degree studies in Industrial Engineering & Management – track Information Technology & Management – at the University of Twente. It is the product of a Master's research on the design and development of an intelligent system that assists employees of the Sales department of Capgemini Outsourcing Netherlands in the selection of suitable references for bid processes.

First, I would like to thanks Capgemini Outsourcing Netherlands for giving me the opportunity to do my Master's assignment at their office in Utrecht. Capgemini Outsourcing provided me with an interesting graduation topic and gave me insight in the ins and outs of European tenders and other bid processes and the services Capgemini Outsourcing delivers to its customers.

In particular, I would like to thank Peter Koning – the knowledge manager of the Sales department of Capgemini Outsourcing Netherlands – who was my supervisor at Capgemini Outsourcing. Peter gave me insight in knowledge management at Capgemini and taught me how to operate the different knowledge management systems used within Capgemini. Furthermore, Peter has programmed the Reference Tracking System that I designed.

My gratitude is also going to my colleagues at the Sales department of Capgemini Outsourcing – especially the bid support employees – who have given me a useful and pleasant six months in their company. Without their input this graduation would not have been a success.

Next, I would like to thank my supervisors at the University of Twente for their feedback, input and support during my graduation. They provided me with the necessary theories, modeling techniques and scientific articles that have shaped my ideas and actions and finally resulted in this graduation report.

At last, I would like to thank my family and friends for all their support, advice and joy during the more than seven years that my study took. Even after some crazy times, they were there for me. I consider myself lucky with family and friends like them, so: thank you very much and I hope that we will keep a whale of a time in the future!

Vincent den Ouden

1. Problem statement & research question

The task of the Sales department of Capgemini Outsourcing Netherlands is responding to requests for information, requests for proposal and best and final offers from all kinds of organizations – both governmental, public and private organizations – that want to outsource (parts of) their information technology.
During the last few years, the Sales department tried to make the bid process more efficient. By improving the bid process they try to save time, hereby reducing costs and achieving deadlines easier. Furthermore, the quality of the replies to the requests for information, requests for proposal and best and final offers should improve, which should result in a higher win rate of more profitable contracts, ultimately improving the margin of Capgemini Outsourcing.
One of the issues that Capgemini Outsourcing is facing is the selection of suitable references. A reference is a piece of information describing a project currently or previously performed at a certain organization. It describes the problems encountered, the activities performed and the technologies used. A suitable reference has to match the requirements as laid down in the request to get a high score from the subcontracting organization.
At the start of this graduation project, the selection of references is done ad hoc. There is no procedure how to select appropriate references. Although there are descriptions available of a lot of outsourcing contracts in the Netherlands and of some major ones originating from other countries, there is no overview of all projects that are going on. Due to this lack of overview, the reference selection depends mainly on the knowledge of the sales employees about previous and current projects, which results in the frequent use of a limited number of references. Other little-known projects are not taken into account, although they may completely satisfy the requirements, while the selected references do not. This subjective reference selection does not only result in a non optimal selection of references, but it also costs a lot of time and effort, especially when references that satisfy the requirements are hard to find.

Reference selection is currently an important topic at Capgemini Outsourcing Netherlands and worldwide. At the last global knowledge management meeting several spearheads are determined. Reference selection was one of them. Reference selection can be seen as knowledge selection. Case-based reasoning is a methodology for problem-solving (Watson, 1999) that probably is useful in knowledge selection. The problem statement above leads to my research question:

How can case-based reasoning improve knowledge selection in reference search?

The solution of this research question can improve the proposal process at the Sales department of Capgemini Outsourcing, reducing time and effort needed for reference selection and improving the match between reference requirements and reference characteristics. Therefore, the research has practical importance.
Next to this practical importance, the research has also scientific importance.

1.1 Scientific importance

Knowledge management is a common topic in scientific research in diverse disciplines like sociology, management science and economics (Davenport et al, 1998). Several research directions, like organizational learning, management of technology and managerial cognition, focus on knowledge (Grant, 1996a). In knowledge management literature six knowledge management activities can be distinguished:

- Knowledge acquisition: the gathering of potentially suitable knowledge from external knowledge sources (Holsapple & Joshi, 2000);
- Knowledge sharing: making internal knowledge available for further reuse and application (Inkpen & Dinur, 1998);
- Knowledge selection: the assessment of internal knowledge to see if it is appropriate for further reuse and application (Zollo & Winter, 2002);
- Knowledge creation: the combination of different types of knowledge into new knowledge (Holsapple & Joshi, 2002a);
- Knowledge application: the integration of knowledge in the output of the organization, such new and improved products and services (Grant, 1996a);
- Knowledge storage: changing the organization's knowledge resources by the retention of new, useful knowledge (Bloodgood & Salisbury, 2001).

These knowledge activities are graphically represented in Figure 1. All these knowledge activities are important for the efficiency of an organization's knowledge management. In contrast to what is commonly believed by practitioners, the major challenge of managing knowledge is not the creation of knowledge, but more its selection (Alavi & Leidner, 1999; Grant, 1996b). This emphasizes the importance of knowledge selection.
Nevertheless, scientific research mainly focuses on knowledge sharing (for example Bhagat et al, 2002; Dyer & Nobeoka, 2000; Hansen, 1999; 2002; Hansen et al, 1999; Lee, 2001; McLure Wasko & Faraj, 2000; 2005) and knowledge creation (for example Cook & Brown, 1999; Nonaka, 1991; 1994; Nonaka & Takeuchi, 1995; Nonaka et al, 2000). To the best of our knowledge, little is written about knowledge selection. Some scholars have investigated the type of knowledge most useful for tasks with certain characteristics (for example Choudhury & Sampler, 1997; Pisano, 1994). Other scholars have researched ways to skip knowledge selection by transform raw data directly into useful knowledge by means of data warehousing, data mining and statistical analysis (for example Datta & Thomas, 1999; Shaw et al, 2001).

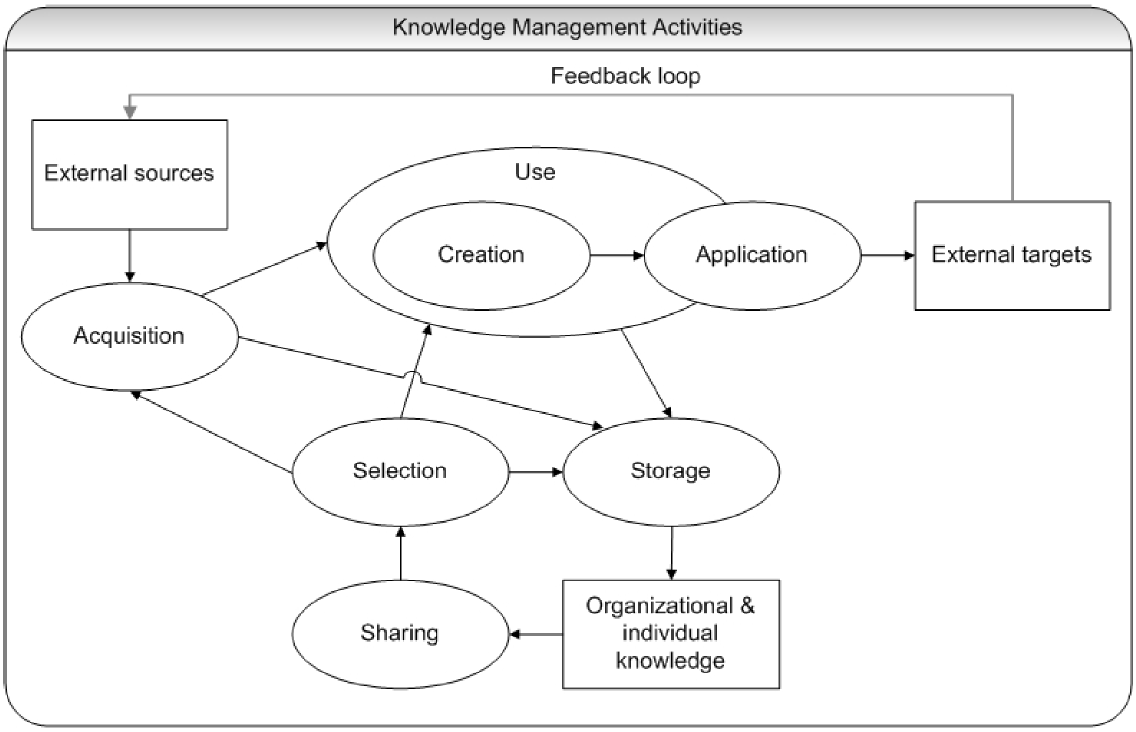


Figure 1: Knowledge activities framework (Holsapple & Joshi, 2002b; adapted)

But to the best of our knowledge, there has been no research to methodologies improving knowledge selection. This gap in knowledge management research is addressed in my graduation assignment. Moreover, as Orlikowski and Iacono (2001) concluded from their review of the full sets of articles published in ten years of Information System Research journals, there is a lack of research that focuses on the information technology artifact. This graduation also addresses that gap.
This shows the scientific importance of my graduation research.

2. Background

In this chapter knowledge selection and case-based reasoning are introduced.

2.1 Knowledge selection

Some scholars have investigated the type of knowledge most useful for tasks with certain characteristics (for example Choudhury & Sampler, 1997; Pisano, 1994). Other scholars have researched ways to skip knowledge selection by transform raw data directly into useful knowledge by means of data warehousing, data mining and statistical analysis (for example Datta & Thomas, 1999; Shaw et al, 2001). But to the best of our knowledge, little is written about knowledge selection technologies and methodologies.

Knowledge selection is part of diverse knowledge management frameworks, although often it is not directly clear that knowledge selection is part of these frameworks due to the use of different names (Holsapple & Joshi, 1999). In Table 1 the knowledge management activities of several knowledge management frameworks are identified and explained. These frameworks are shown in Figure 2 to Figure 7.

Knowledge management framework	Knowledge management activities
Model of Knowledge Transfer (Szulanski, 1996)	• Initiation: the discovery of a need and potential solutions • Implementation: the knowledge transfer between the source and the recipient • Ramp-up: the use the transferred knowledge • Integration: the use of the transferred knowledge becomes routine
Organizational Knowledge Management Model (Arthur Anderson & APQC, 1996)	• Sharing: making knowledge available for reuse • Creation: the production of new knowledge • Identification: the detection of (potentially) useful knowledge • Collection: the gathering of (potentially) useful knowledge • Adaptation: the modification of existing knowledge to meet a certain need • Organization: the restructuring of knowledge • Application: the reuse of existing knowledge
KPMG Knowledge Management Process (Alavi, 1997)	• Acquisition: the creation and development of knowledge • Library management activities (indexing, filtering, linking): the screening, classification, cataloging, integrating and interconnecting of knowledge • Distribution: the packaging and delivery of knowledge • Application: the use of knowledge

Table 1: Knowledge management activities in diverse knowledge management frameworks

Knowledge management framework	Knowledge management activities
Knowledge Reuse Process (Markus, 2001)	• Capture or documenting: the creation of documents as by-product or as separate product • Packaging: the structuring, formatting, and indexing of documents • Distribution or dissemination: the delivery of knowledge • Reuse: the application of knowledge
Knowledge Evolution Cycle (Zollo & Winter, 2002)	• Generative variation: the generation of a set of ideas about how to solve a problem • Internal selection: the evaluation of the set of ideas for usefulness • Replication: the transfer of knowledge to the relevant parties; this contributes new (raw) information • Retention: the use of the transferred knowledge becomes routine
Knowledge Management Activities Framework (Holsapple & Joshi, 2002b)	• Acquisition: the identification of knowledge in the environment of the organization • Selection: the identification of useful knowledge within the existing knowledge resources of the organization • Internalization: the incorporation of the new knowledge in the knowledge resources of the organization • Use: o Generation: the creation of knowledge by processing existing knowledge o Externalization: the application of knowledge

Table 1 (continued): Knowledge management activities in diverse knowledge management frameworks

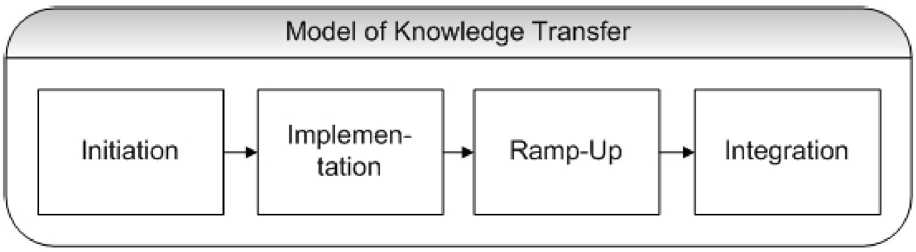


Figure 2: Model of Knowledge Transfer (Szulanski, 1996)

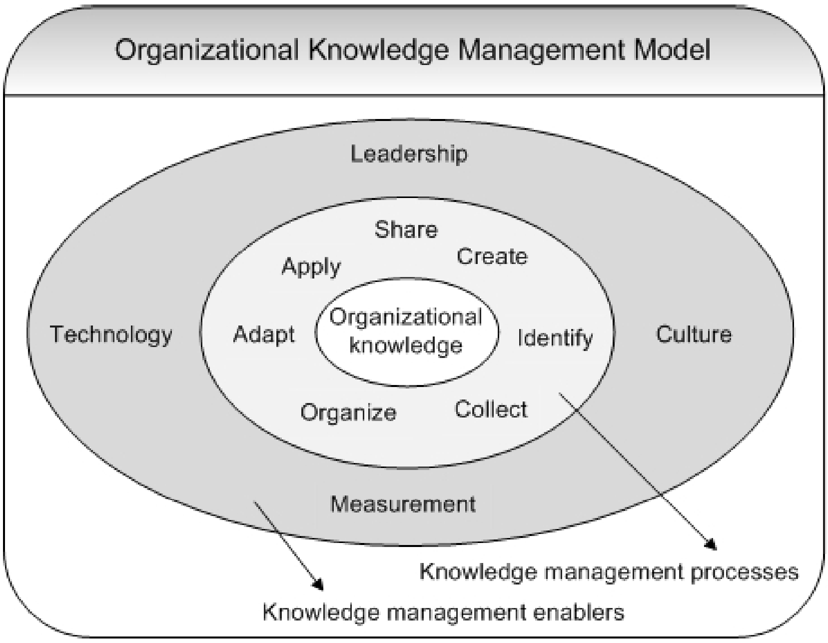


Figure 3: Organizational Knowledge Management Model (Arthur Anderson & APQC, 1996)

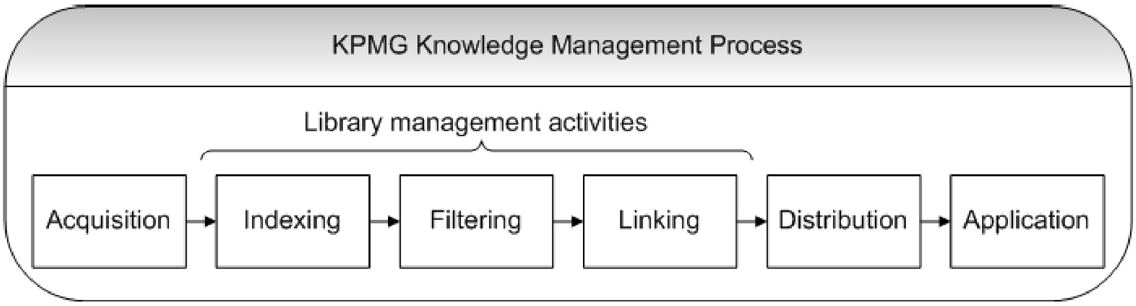


Figure 4: KPMG Knowledge Management Process (Alavi, 1997)

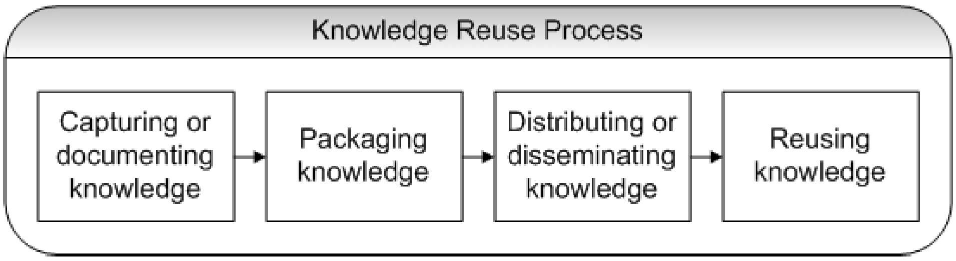


Figure 5: Knowledge Reuse Process (Markus, 2001)

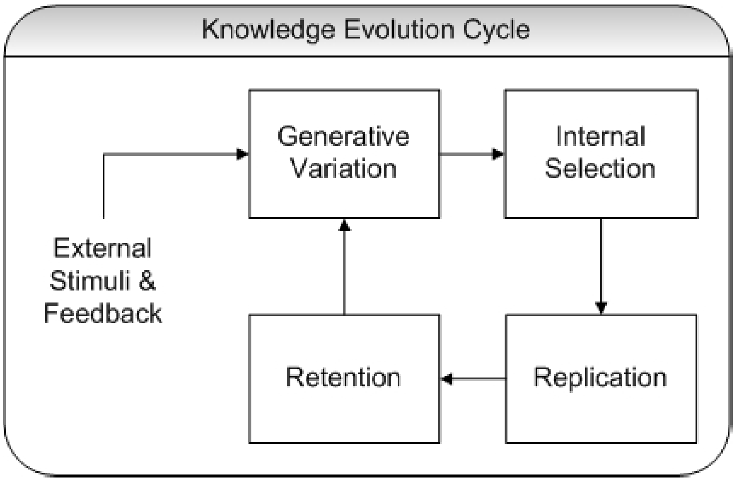


Figure 6: Knowledge Evolution Cycle (Zollo & Winter, 2002)

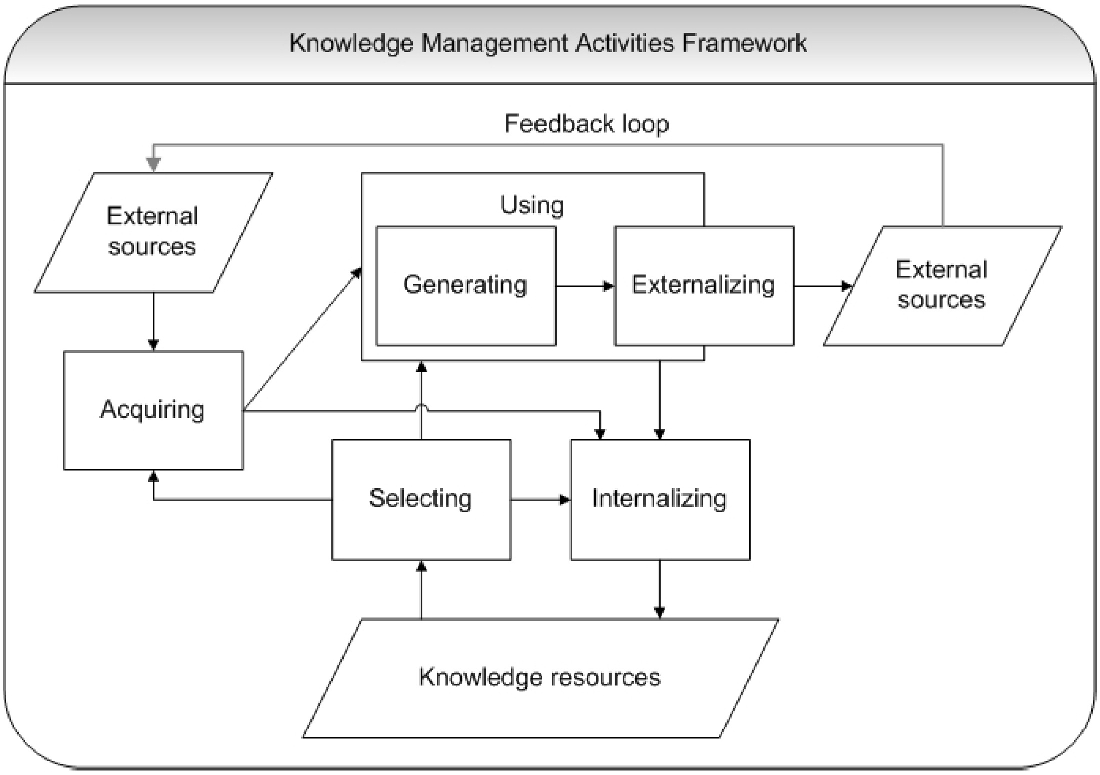


Figure 7: Knowledge Management Activities Framework (Holsapple & Joshi, 2002b)

Knowledge selection is part of all these knowledge management frameworks, although it is sometimes not clear at first glance. In the Model of Knowledge Transfer (Szulanski, 1996) knowledge selection is part of the initiation phase. It is covered by knowledge identification and knowledge collection in the Organizational Knowledge Management Model (Arthur Anderson & APQC, 1996). The library management processes indexing and filtering in the KPMG Knowledge Management Process (Alavi, 1997) deal with the selection of knowledge.

Knowledge management framework	Location of knowledge selection	Knowledge selection definition
Model of Knowledge Transfer (Szulanski, 1996)	Part of initiation stage	The discovery of potentially useful knowledge to meet a certain need
Organizational Knowledge Management Model (Arthur Anderson & APQC, 1996)	Covered by identification and collection	The detection and gathering of (potentially) useful knowledge
KPMG Knowledge Management Process (Alavi, 1997)	Covered by indexing and filtering	The screening of knowledge
Knowledge Reuse Process (Markus, 2001)	Part of capture or documenting knowledge phase	The documenting of useful knowledge when creating products
Knowledge Evolution Cycle (Zollo & Winter, 2002)	Internal selection	Created ideas are evaluated to see if they are useful to solve a certain problem
Knowledge Management Activities Framework (Holsapple & Joshi, 2002b)	Selecting	The identification of (potentially) useful knowledge within the existing organizational knowledge resources

Table 2: Knowledge selection as part of diverse knowledge management frameworks

And in the Knowledge Reuse Process of Markus (2001) capturing and documenting is synonym for knowledge selection. Only in the Knowledge Evolution Cycle (Zollo & Winter, 2002) and the Knowledge Management Activities Framework (Holsapple & Joshi, 2002b) it is directly clear that knowledge selection is part of the model: respectively called internal selection and selecting. In Table 2 it is summarized where knowledge selection is placed within the discussed knowledge management frameworks.
Furthermore, in Table 2 the definition of knowledge selection as used in the diverse frameworks is given. These definitions can be combined into the following definition of knowledge selection: knowledge selection is the activity of identifying the requested knowledge within the organization’s internal knowledge resources (Holsapple & Joshi, 2002b).

Several sub-activities can be distinguished in knowledge selection. First, the internal knowledge resources of the organization have to be screened to identify the requested knowledge. This sub-activity is called recognition. Screening involves valuing and filtering of knowledge. When appropriate knowledge is identified, the knowledge has to be captured, collected and gathered from the internal knowledge resources. This is the second sub-activity of knowledge selection. The last sub-activity of knowledge selection is packaging. The retrieved knowledge has to be couched into a suitable format to ensure further use. This sub-activity involves distilling, refining, orienting, interpreting, assembling, and transforming the

knowledge into an appropriate representation (Alavi, 1997; Holsapple & Joshi, 2002a; 2002b; Markus, 2001).
These different sub-activities encounter numerous issues. Some organizations rely heavily on the tacit knowledge owned by their organizational members. But this knowledge can only be accessed, if the organization owns one or more directories that identify the existence, location, and means of the knowledge held by the individuals (Anand et al, 1998). These directories are known as 'knowledge yellow pages' (Grover & Davenport, 2001). The same applies for organizations that rely on explicit knowledge stored in repositories. Without a good and effective search engine, users are discouraged from searching and reusing knowledge, especially in large collections of knowledge (Alavi & Leidner, 2001). Classification and cataloguing of the content of the internal knowledge resources that reside in the organization's repositories can facilitate the screening of these resources (Alavi, 1997).
When knowledge is scattered over various knowledge resources it is hard to identify and retrieve suitable knowledge. This can be facilitated using diverse tools and techniques like knowledge yellow pages and search engines. One major issue concerning knowledge selection is what tool or technique should be used to make the selection activity effective and efficient for each of the main types of knowledge resources, like individuals and repositories (Holsapple & Joshi, 2002b).

2.2 Case-based reasoning

Case-based reasoning is a methodology for problem solving (Watson, 1999). This problem solving can take place in the minds of people or it can use intelligent systems (Kolodner, 1992). The classic definition of case-based reasoning is solving new problems by using or adapting solutions to old problems (Riesbeck & Schank, 1989 as cited in Watson, 1999). Case-based reasoning is used to solve problems in diverse disciplines, like the legal domain (a judge coming to a verdict by referring to other similar trials) (Kolodner, 1992), health care (a doctor coming to a possible diagnosis seeing a familiar combination of symptoms) (Kolodner & Kolodner, 1987) and customer service (a service desk employee solving a customer's call by using a problem resolution system) (Acorn & Walden, 1992). Moreover, case-based reasoning is also used extensively in day-to-day common sense, for example when making a choice in a restaurant taking into account previous experiences with the offered dishes (Kolodner, 1992).
There are two styles of case-based reasoning: problem solving case-based reasoning and interpretive case-based reasoning. In the problem solving style, old solutions can provide almost-right solutions to new problems. These solutions need minimal adaptation to provide a suitable solution to the new situation. When you want to prepare a dish for some friends, you use your knowledge from other meals with these friends for deciding what dish you will prepare. From the past meals you remember ingredients your friends like and do not like. This knowledge can be used directly in deciding what meal to cook. In the interpretive style, new problems are evaluated in the context of old situations. A lawyer uses interpretive case-based reasoning when he supports an argument with old cases. Not the direct solution to old problems is used, but the context of old situations. With problem-solving case-based

reasoning the solutions to old problems can be used straightforward by solving a new problem, while with interpretive case-based reasoning not the solution, but the reasoning can be used in the new situation (Kolodner, 1992).

Within case-based reasoning six activities can be distinguished. These activities are shown in Figure 8. In this figure four types of building blocks can be distinguished: a rectangle, a rectangle with an undulating bottom, a diamond and a cylinder. A rectangle represents a case-based reasoning activity. A rectangle with an undulating bottom represents a document. Two overlapping rectangles with undulating bottoms represent several documents. A diamond represents a decision moment. The cylinder represents a repository, where documents are stored.
The six case-based reasoning activities are (Aha, 1998; Allen, 1994; Kolodner, 1992; Watson, 1999):

- Representation: the creation of a problem description. This is the input of the person or the intelligent system performing case-based reasoning.
- Retrieval: the reasoner retrieves similar old cases to the new problem description from the case library. This case library could be the memory of the reasoner or a knowledge repository.
- Reuse: the application of one or more of the retrieved old cases, perhaps by combining them with each other or with other knowledge sources.

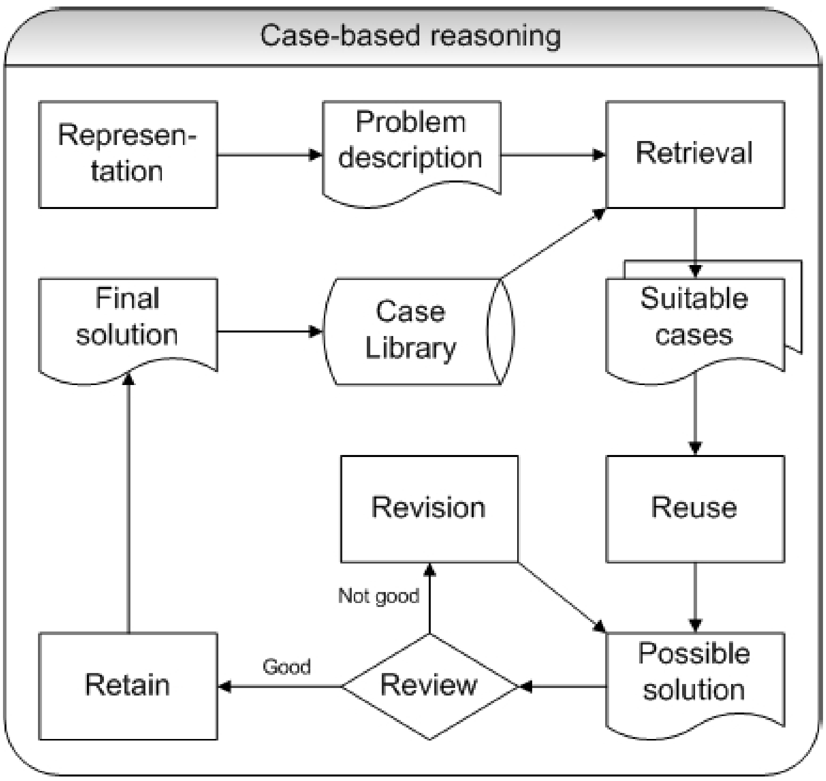


Figure 8: Case-based reasoning activities (Watson, 1999; adapted)

- Review: the evaluation of the outcome when applying the revised old solution to the new problem. The case needs further revisions if the outcome is not acceptable.
- Revision: the modification of a potential solution if necessary to better fit the new problem.
- Retention: when the new solution gets a positive review, it can be stored in the case library (the knowledge repository or someone's memory). A reasoner can become more efficient by remembering more old cases.

Case-based reasoning has some common problems. First, there is the indexing problem. The indexing problem is the problem of retrieving applicable old cases with appropriate response, despite the different features and situations of the old cases. The second common problem is the ballpark problem. The ballpark problem is the problem that old cases may be quite extended, while only a part is important for the new problem. The third problem is caused by the fact that old cases rarely match new problems completely. Old cases must thus be adapted to fit the new situation. In the fourth place, there is the problem if the chosen case is the best available case. Finally, there is the storage problem. How should the new case be stored in the case library and be catalogued to make sure that the case is searchable in the future, but does not return at every search (Kolodner, 1992).
Some of these case-based reasoning problems can barely be reduced by automating the case-based reasoning processes. The revision of the old case to the new situation can often not be replaced by an intelligent system, because this needs some human intelligence. This is also the case of the evaluation of the suitability of the chosen case. But an intelligent system can help in reducing the indexing problem, the ballpark problem and the storage problem by automating and centralizing the different processes. The number of problems that an intelligent system reduces depends on the scope of the intelligent system. An electronic case-based reasoner can vary from a retrieval-only system (assists the user only in finding cases) to a fully-automated system, supporting all activities (Kolodner, 1992).

3. Research method

Natural research or behavioral science is the traditional scientific approach (Hevner et al, 2004; March & Smith, 1995). It is science concerned with explaining how and why things are or in other words about understanding reality. Natural science and behavioral science consist of two main activities: discovery and justification. Discovery is the process of generating scientific claims, like theories and laws. These hypotheses are tested in the justification phase of natural research (March & Smith, 1995). Examples of natural research and behavioral science are action research, case studies and experiments.
In this graduation assignment the focus is not on understanding reality, but on changing reality. Therefore, natural research is not a suitable research method. The research method used to change reality is design science.

3.1 Design science

Unlike natural science and behavioral science, design science is not about creating and testing hypotheses. Design science is about creating things that serve human purpose and change reality. Design science consists of two main activities: designing, developing and building the artifact and evaluating the impact of the artifact (March & Smith, 1995).
Design science can result in four different research outputs: constructs, models, methods and instantiations. A construct is a vocabulary of a domain to characterize phenomena. A model is a set of propositions or statements expressing relationships among constructs. A method is a set of steps used to perform a task. Methods are used in, but not produced by natural science. An instantiation is a realization of an artifact in its environment (March & Smith, 1995). The ultimate goal of this research graduation is creating an instantiation, a prototype of the reference selection system and testing its impact.
Five stages can be distinguished in design science (Vaishnavi & Kuechler, 2005). These stages are shown in Figure 9.
Design science starts with the awareness of a problem. To solve this problem an artifact should be created. During the suggestion stage a basic idea about the potential solution is created. By developing the artifact the suggestion is elaborated. During this development stage a prototype of the suggestion is actually build. The suggestion stage and the development stage enclose the first main activity of design science. When a prototype of the artifact is developed and built, an evaluation is needed to see if the artifact has the desired result. This is the second

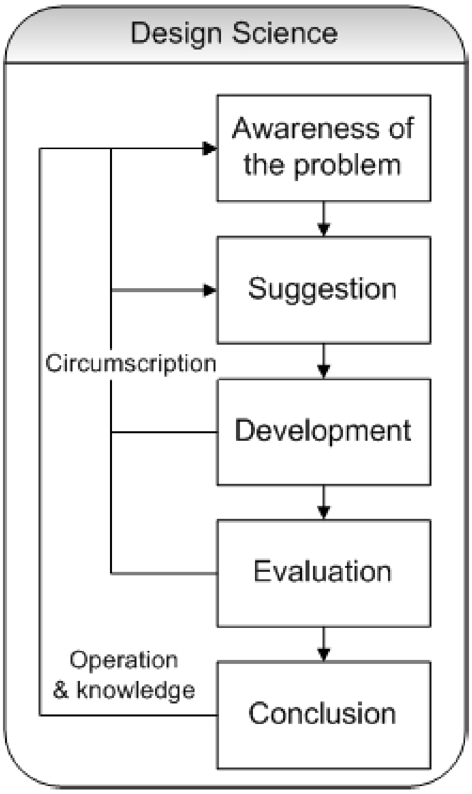


Figure 9: Design science stages (Vaishnavi & Kuechler, 2005; adapted)

major design science activity. During this graduation study action research is used as evaluation method. Action research is discussed in the next section.
Both the development and the evaluation of the artifact create new insights. These insights can result in new problem boundaries or in other words a circumscription of the problem. During design science some iteration can occur in which the problem awareness, the suggestion and the development of the artifact are reconsidered.
When the assessment of the prototype of the artifact results in a satisfactory evaluation, the design research is finished. Next to the prototype of the artifact the research results in some conclusions. Both the conclusions and the artifact change the reality, which could result in new problems. Furthermore, the conclusions add to the available scientific knowledge. Design science can result in new insights how to tackle a certain problem. New design science loops are possible.

3.2 Action research

Natural research is not suitable to create an artifact, but it can be used to evaluate the impact of the artifact. During my graduation, I use action research to evaluate the impact of the created artifact using design science. Action research is described here as the evaluation method used in a design science study.
I have chosen for an action research approach as evaluation method, because this method produces highly relevant research results, because it is grounded in practice (Baskerville, 1999). It is more reliable than a survey approach, because in action research the emphasis is on what practitioners really do, instead of what they say they do, which is often the case with surveys (Avison et al, 1999). A quite obvious research method is the case study approach. However, this approach is not appropriate, because it not suitable to measure the impact of a created situation – like the case with the implementation of the artifact. A case study is meant to describe a situation. During the evaluation the impact of the artifact should be evaluated. This is possible with a qualitative research method like action research.
In action research five stages can be distinguished (Baskerville, 1999). These stages are shown in Figure 10.
The first and last stages of action research – diagnosing the problem and specify learning – are similar to the problem awareness stage and conclusion stage of design science. The other three stages are the logical consequence of each other. First, the researcher has to determine how to assess the impact on the current situation of the created artifact. After this, these assessment actions should be performed. Finally, the results should be evaluated to see if the artifact fulfils its purpose.

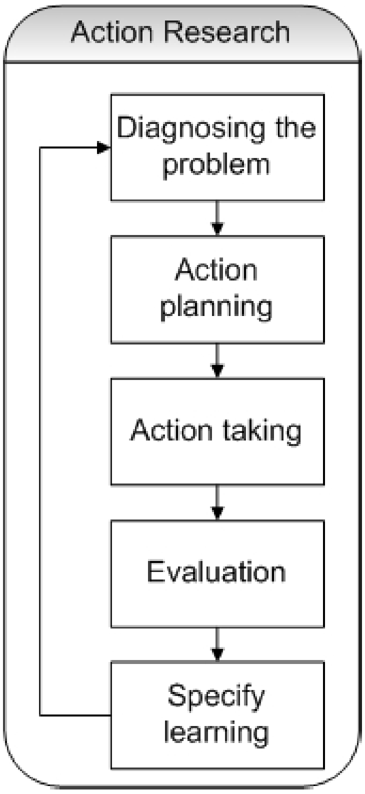


Figure 10: Action research stages (Baskerville, 1999)

The results from the action research evaluation of the artifact could result in reconsiderations for the created artifact. A new design science cycle would occur.
In the next section design science and action research are combined to visualize the approach used in this graduation study.

3.3 Graduation research method

During this graduation study a combination of design science and action research is used. Design science is the main research method, while action research is used to evaluate the impact of the artifact built on the real world. The different stages of the graduation research approach are shown in Figure 11.

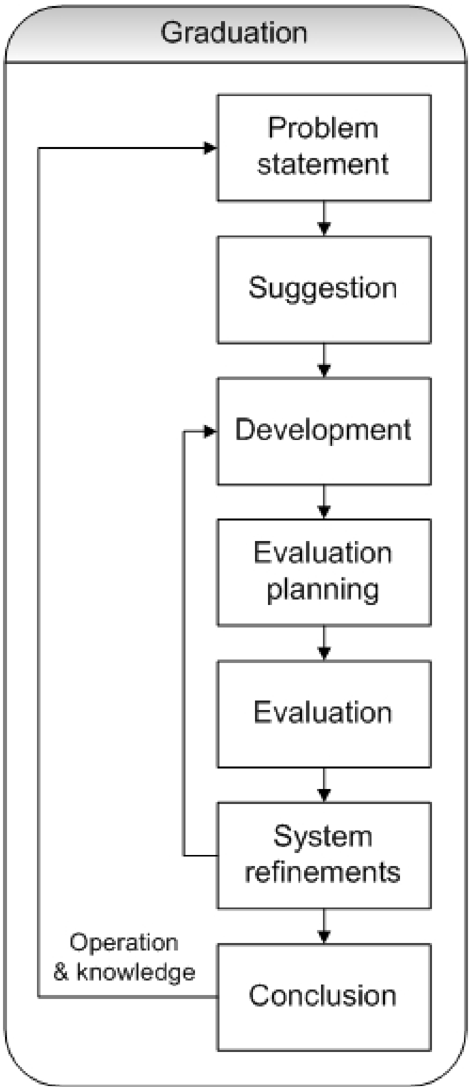


Figure 11: Graduation research stages

The graduation research started with a problem statement. This problem statement is equivalent to the problem awareness stage of design science. This stage is discussed earlier in Chapter 1 of this graduation report.
To solve this problem an artifact should be created. During the suggestion stage a basic idea about the potential solution is created. This suggestion is based on scientific literature about case-based reasoning and knowledge selection. Case-based reasoning is a methodology that seems to offer a suitable way to select appropriate references during bidding processes. This stage is discussed in Chapter 4 of this graduation report.
This suggestion is further elaborated during the development stage of this graduation. This stage is discussed in Chapter 5. During this stage a prototype of the suggestion is developed. In Chapter 6 a prototype of the created artifact is presented.
When a prototype of the artifact is developed and built, an evaluation is needed to see if the artifact has the desired result. This is done during the action research part of this graduation. The three sub stages of the action research part are discussed in Chapter 7. First, an impact model is created that shows the expected evaluation results. These expectations are expressed in several hypotheses. Furthermore, a plan is set up how to measure the impact of the created prototype of the artifact. The hypotheses are tested using the action research method. This evaluation results in some system refinements.

After these system refinements are implemented the impact of the artifact is assessed once again. When the impact of the artifact reduces the problems described in Chapter 1, both practical and scientific conclusions are drawn. Finally, limitations and practical and scientific recommendations are described.

4. Design of the Reference Tracking System

As stated in Section 3.1, the ultimate goal of this graduation research is creating an instantiation, a prototype of the reference selection system and testing its impact. The reference selection system is named Reference Tracking System by Capgemini colleagues in India. This chapter deals with the requirements and design of the instantiation. The result of this chapter is a series of models that show multiple views on the reference selection system. First, an introduction to bid processes is presented. After that, this chapter zooms in at reference selection, which is viewed as a case-based reasoning cycle. Thirdly, a basic idea of the system is presented. After that the requirements that the system should satisfy are discussed. At last, the system is examined from the four views that are part of the ARIS methodology.

4.1 Bid processes

This graduation assignment takes place at the Sales department of Capgemini Outsourcing Netherlands. In a lot of consultancy and outsourcing organizations, delivery (the execution of the assignment) and sales are not separated. At Capgemini Outsourcing Netherlands, there is a single department that focuses on responding to service requests.

A typical bid trajectory consists of several phases. Often the setup of a bid trajectory and the throughput time of the different phases are known before the bid process starts. The phases of a bid process are shown in Figure 12. In this figure three types of building blocks can be distinguished: a diamond, a XOR and a rectangle. A diamond represents a decision moment. An XOR means that one or the other path is followed. A rectangle represents the following step in the bid trajectory.

A typical bid process follows the central path in the figure and omits the market consultation and the best and final offer. The phases of typical bid process are (Schouten et al, 2007):

- Selection phase: during the selection phase the contracting party sends out a request for information. By setting minimum requirements the contracting party filters the vendors. All vendors that do not achieve the minimum requirements drop out. The selection phase focuses mainly on the vendor details and results in a ranking.
- Allotment phase: during the allotment phase the contracting party sends out a request for proposal to the parties that have achieved the highest rankings in the previous phase. This phase focuses more on the details of the assignment and less on the vendor details. This phase usually results in one vendor that should execute the assignment. In large bid processes, there is sometimes a second allotment phase in which the contracting party sends out a best and final offer.
- Contracting: in this phase the selected vendor and the contracting party elaborate on the details of their future relationship. This is the end of the bid process. When the contracting phase is finished, the execution of the assignment can start.

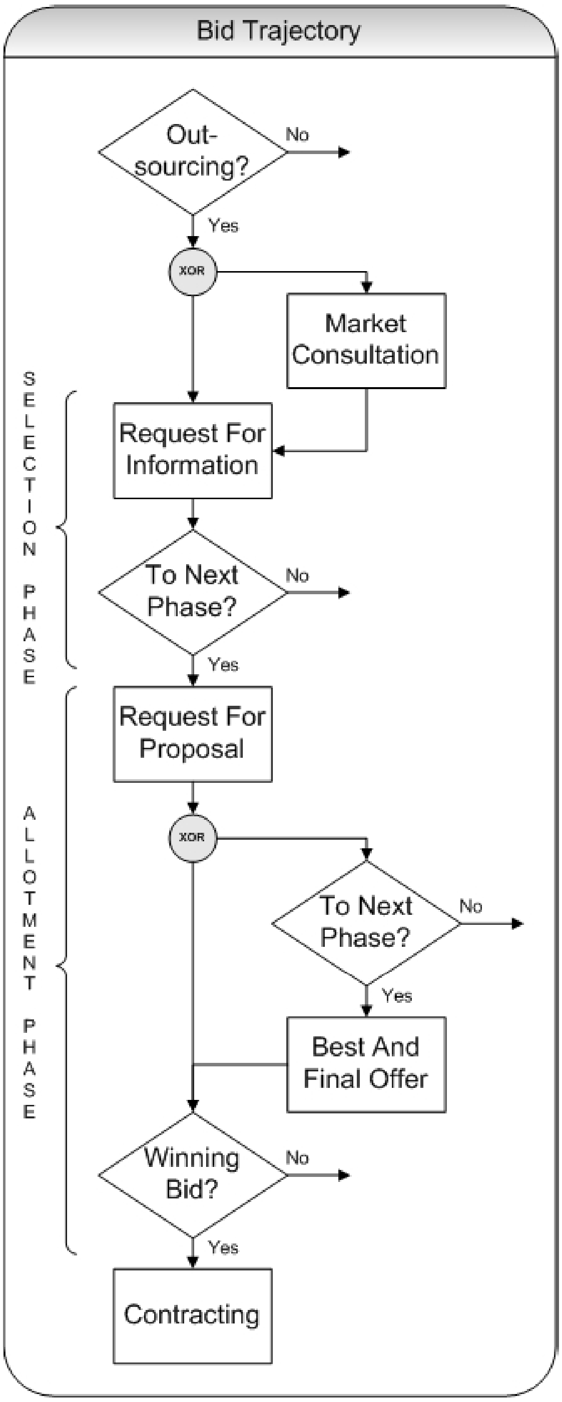


Figure 12: Bid trajectory phases

The phases above sketch a typical bid process. However, variation is possible. When organizations want to know what possibilities the market has to offer they can start a market consultation. Furthermore, several question rounds or a demonstration of the offered solution can be part of the bid trajectory (Schouten et al, 2007).

When you zoom in at the response process to a certain request, several activities can be distinguished. For the bid process it does not matter, whether the request to be answered is a request for information, a request for proposal or a best and final offer. Therefore, in the remainder of this graduation report the term request is used instead of request for information, request for proposal and best and final offer.

The different activities within a request response process are illustrated in Figure 13. In the figure, the square represents an activity, while a diamond is a decision moment.

When a certain request is received, the sales team has to decide whether they would respond to the request. Some of the considerations are the value of the request and the chance to win the service request (due to competition).

When the sales team has decided to respond to the request, the content of the request is evaluated. Some questions and parts of the request could be answered by reusing a piece from an old response to a request (a so called nugget) from the knowledge repository of the sales department. Other questions cannot be answered using a nugget and a new answer has to be created.

When the answers are ready they are reviewed by other members of the sales team. When the questions are answered well and the answers are good enough, the answers are combined to create the response to the request. If this is not the case, the answer is adapted until it is satisfactory.

The response to the request is send to the contracting party, who evaluates the response. Besides, it is stored in the knowledge repository of the sales department.

One of the questions asked in a request is whether the vendor can show its capabilities regarding the assignment by presenting some references. Reference selection is the next topic that is discussed.

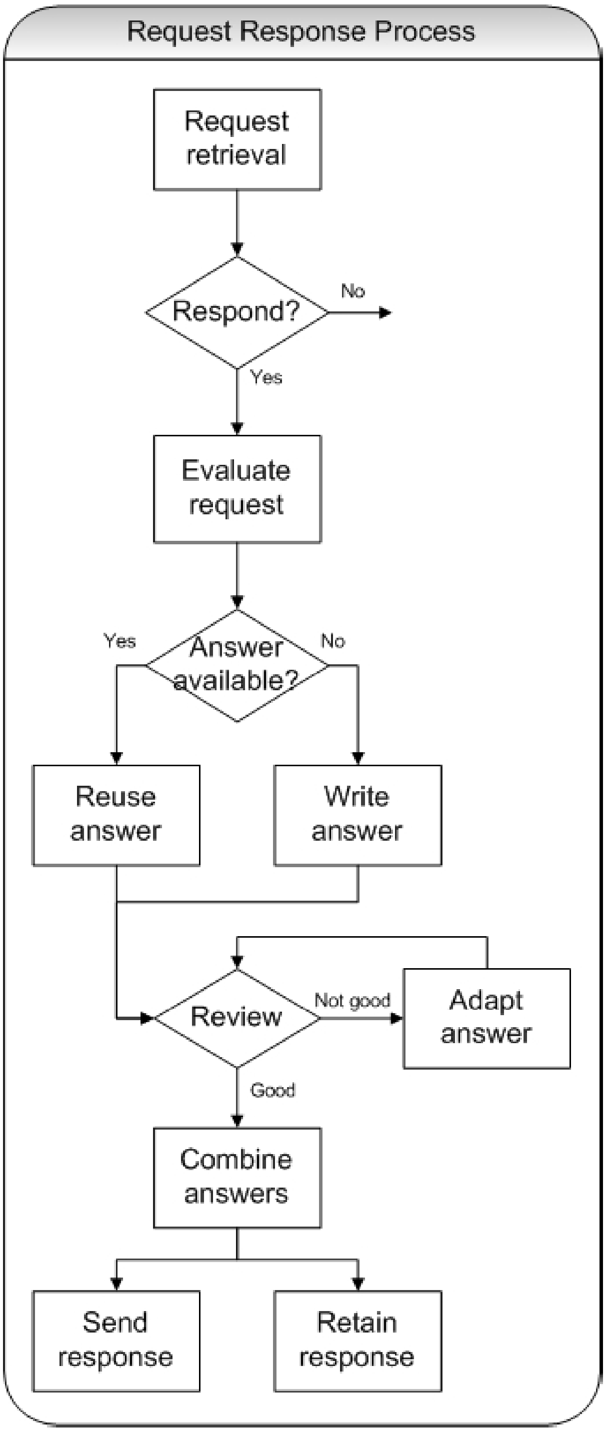


Figure 13: Request response process

4.2 Case-based reasoning in reference selection

Case-based reasoning is well suitable for knowledge management applications (Aha, 1998). All the case-based reasoning activities discussed in Section 2.2 can be recognized in the reference selection process at the Sales department of Capgemini Outsourcing. The six case-based reasoning activities applied to the reference selection process within the Sales department of Capgemini Outsourcing are shown in Figure 14.

First a request is received by the Sales department. This problem representation is created by the customer. The request is the input of the Sales department. The request consists of a description of the tasks to be outsourced and diverse questions concerning these tasks. Furthermore, the request sketches the requirements that the references must satisfy.

The sales employee selects some references that meet the requirements. The reference selection is done ad hoc: no procedure how to select appropriate references is available. The sales employee uses his knowledge about old references and the knowledge of his team members. The sales employees retrieve specific reference documents created during previous bid trajectories or general reference documents created by the service managers – responsible for all activities performed for a client. Pieces of these documents that respond to questions of the client are reused.

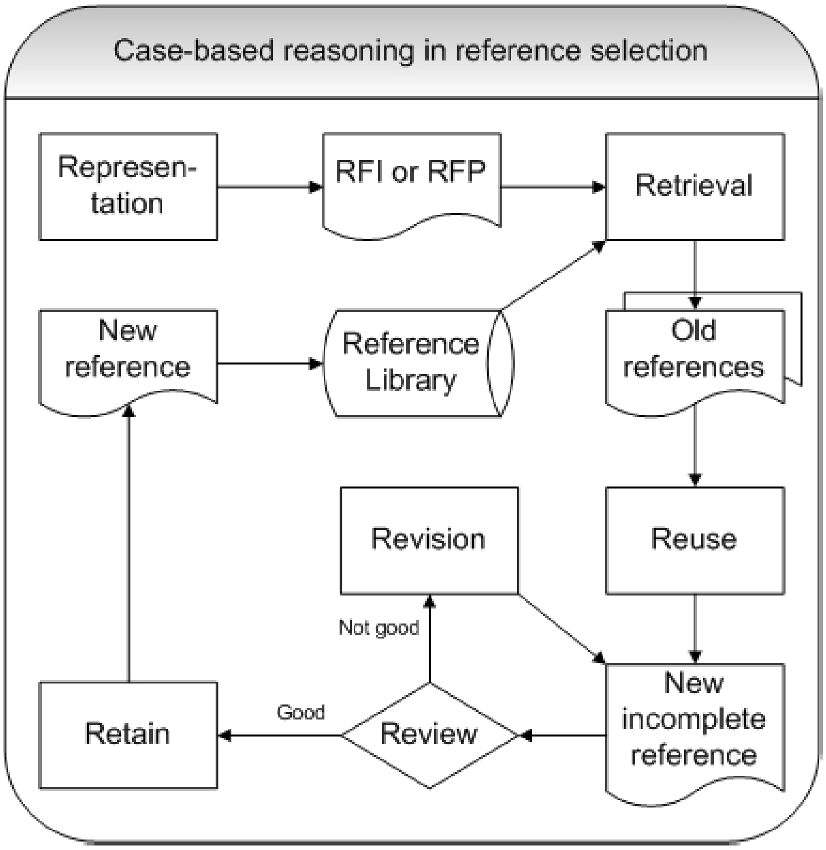


Figure 14: Case-based reasoning in reference selection

During a first review by the sales employee gaps in the new reference document are noticed and filled in if possible. The new reference document is send to the service manager, who fills in the remaining gaps and checks if all content is correct. After this review and revision, the reference becomes part of the response to the request. The last evaluation takes place at the client, but this evaluation does not result in a revision, but in a score and a ranking. When the final document is sent to the client, the separate references are placed in the knowledge repository of Capgemini Outsourcing.

At the start of this graduation project, most activities described above are performed manually. But case-based reasoning can also be used for building an intelligent system (Kolodner, 1992). When building an intelligent system based on case-based reasoning, it may use any appropriate technology (Watson, 1999). In the remainder of this chapter, the system based on case-based reasoning is further designed.

This intelligent system targets at reducing the common case-based reasoning problems discussed in Section 2.2 (the indexing problem, the ballpark problem and the storage problem) by automating the processes and centralizing the references.

4.3 Basic idea of the system

During this graduation research an artifact should be build that assist case-based reasoners in selecting appropriate references. There are several possible systems that can help in selecting references.

The first possible system consists of a sole search engine. The keywords and facts that are searched for are in the reference documents. An information management tool like Copernic works like this. Copernic builds an index file of all words inside documents ignoring articles, adverbs and often-used verbs like “the”, “all” and “have”. This search method is called term frequency–inverse document frequency weighting (Aizawa, 2003). When a user carries out a search task, Copernic returns all documents that contain the requested term without any ranking (Copernic, 2008). This option has some major disadvantages. First, all documents should be on a single or on a few locations, otherwise the search engine cannot find the documents. Secondly, the search result depends largely on the type of the reference document and the language and keywords used within the reference document. Not all document types are suitable to use in such a system. When a new document format is introduced, there is the possibility that the system needs to be adapted. Within Capgemini the regions communicate mainly in their own language. Reference documents are often written in native languages. Many search engines struggle with the large variety in document languages. Many keywords have synonyms that are all used in the reference documents. This limits the searchability and causes the need for several search actions to get a complete overview of the available references about a certain topic. Finally, this option has the disadvantage that more than one reference document concerning the same assignment (but with a different creation date and content) can be returned, limiting the convenient arrangement of the search result. It is clear that this option is not very appropriate to build a reference selection system.

The second option is a system that contains the entire reference documents. In such system the documents are part of the system and cannot be accessed without using the system. An example is the global knowledge management system used within Capgemini, KM2.0. Every user can upload its documents, so other users can reuse these. All the documents are at one location that is available to all users. Such system has also some disadvantages. One of the problems is the same as the last problem concerning the sole search engine. Multiple reference documents concerning the same referent can be stored in the system and are returned as result of a search task. This limits the convenient arrangement of the search result. Moreover, the amount of content in the system increases fast. The large amount of content is hard to manage. This implies the risk that right references are not traceable due to the amount of old content in the system, a problem also encountered with the old knowledge management system of Capgemini – Knew. Finally, when the system does not work, all reference documents are unavailable, because they are in a database part of the system. Capgemini has the demand that the reference documents should be accessible even if the system is unavailable, so this is an undesirable dependency. This option is also not suitable to build a reference selection system.
The third possibility is a sort of shell around the reference documents that contains the keywords and facts describing the references and some search functionality. Examples of such systems are the scientific literature search engines Scopus and Web of Science (Scopus, 2008; Web of Science, 2008). These systems contain the author, article title, journal title, year of publishing, keywords and abstract of many articles from scientific journals. A user searches for articles about a certain topic and the article library returns potentially suitable articles. The article itself is available on the website of the publisher. The third system seems the most appropriate option, because the disadvantages of the other options do not trouble this system. The system can be independent of reference document type. The language and keywords can be prescribed independent of the language and terms used in the reference documents. Not much effort is needed for including new references, because only some keywords and a link to the reference document have to be placed in the system. Because the system only contains keywords and links to reference documents, the documents are available even if the system breaks down. Only the search possibility is not available in case of a system break down. The Reference Tracking System designed and created during this graduation should be a shell around the reference documents that contains the keywords and facts describing the references and some search functionality.

4.4 Requirements

System requirements can be divided into functional, nonfunctional and performance requirements (Thiadens, 2005). As shown in Section 4.2, the reference selection process can be modeled as a case-based reasoning cycle. The quality of a solution derived using case-based reasoning depends on four aspects: the experience of the case-based reasoner, the ability of the reasoner to translate old cases into new situations, the ability to adapt old cases to meet the new situation and the ability to learn from its experience and to remember new cases (Kolodner, 1992). Three of these aspects can be supported by an intelligent system.

Moderating and adapting old cases to new requirements is an activity that requires human intelligence and cannot be done by an intelligent system. The other three aspects can be facilitated by a system by satisfying several functional and nonfunctional requirements. These requirements and the performance requirements are discussed in this section.

4.4.1 Functional requirements

The Reference Tracking System should assist users in selecting suitable references for responses to customer's requests. It should provide an overview and a library of available reference documents.

The ability of the case-based reasoner to translate old cases into new situations can be supported by calculating the match between the requirements and the different references that are in the reference library and presenting the best matching results. Two common problems with matching are the indexing problem and the ballpark problem.

The indexing problem is the problem of retrieving applicable old cases with appropriate response, despite the different features and situations of the old cases (Kolodner, 1992). No two organizations are the same. So when searching for references to respond to a new request, there is a large possibility that none of the available references match all requirements. For example, when a university in the Netherlands wants to outsource its network management, Capgemini searches for other universities within the Netherlands for which Capgemini manages the LAN facilities. But when Capgemini only takes care of network management for high schools, the reference library contains no reference that matches all statements. The high school references should also be presented, because they may be suitable due to the similarity between universities and high schools. The reference selection system should thus provide a mechanism that indexes the match (hit rate) between the different references and the requirements and present the best matching references.

The ballpark problem is the problem that old cases may be quite extended, while only a part is important for the new problem (Kolodner, 1992). Often, a reference describes diverse activities performed for an organization within a certain contract. But a new customer request can demand for only one or a few of these activities. In that case, the reference is appropriate, although it comprises more activities than asked. Take for example the reference of a financial organization in the Netherlands. Capgemini performs for this organization both application management and infrastructure management. Capgemini takes care of their desktop management, hosts their servers and mans the service desk. When a third organization wants to outsource its desktop management, this financial organization is a suitable reference, although the contract contains more than only desktop management. The reference selection system should thus provide a way to select references that comprise more than the requested service.

By providing a means to insert new references in the Reference Tracking System, the system can become more intelligent. By inserting new references, the storage problem occurs. The storage problem is the problem how the new case should be stored in the case library and be indexed to make sure that the case is searchable in the future, but does not return at every search (Kolodner, 1992). This problem is about what keywords and the level of detail needed in the case library. When a very low level of detail is used, there is a very rough reference classification. Many less useful references are returned when a search is performed. When the level of detail is too high, the complexity of the system increases and therefore the usefulness decreases. To create a useful system the description of the references in the system should have the right level of detail. Furthermore, many keywords have synonyms and abbreviations and can be expressed in multiple languages. These problems are visualized in Figure 15. In this figure is illustrated that the entity keywords has two relationships with itself. Many keywords have synonyms – sometimes even more than one – and keywords are often part of some hierarchy – the level of detail problem. To tackle these problems the system should provide a means to manage the keywords used.

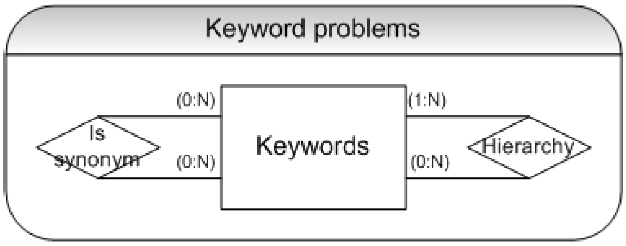


Figure 15: Problems with keyword

Summarizing, the functional requirements of the reference selection system are:

- The system should provide a mechanism that indexes the match between the different references and the requirements (hit rate) and present the best matching references.
- The system should provide a way to select references that comprise more than the requested service.
- The system should contain a means to enter new references.
- The system should contain a means to manage the keywords used.

4.4.2 Nonfunctional requirements

One of the purposes of the Reference Tracking System is to provide an overview of the globally available references and to support the reference selection within bid processes all over the world. To be used by Capgemini employees from all regions, it should be supported by the users all around the world.

The experience of the human case-based reasoner consists of all the knowledge in his memory. The experience of an intelligent system is made of the knowledge in the database of the intelligent system. This knowledge is combined with the knowledge of the user of the system. In the case of the reference selection system, the amount of available references in the case library is the experience and determines partly the quality of the solution. The more references are inserted in the case library the higher the average match between the references and the requirements. To give a better overview of the available references, the system should contain references from all regions of Capgemini. The reference selection system should thus contain as much references as possible originating from all regions of Capgemini. Moreover, the system should provide a single point of access to all references worldwide.

The references in the case library of the system are confidential. This confidential knowledge should be protected against unauthorized access. Moreover, not all users are allowed to change, alter and insert references. The system should thus contain some security measures

that protect the knowledge in the case library of the system and in which user rights can be assigned.
Additional nonfunctional requirements can be deduced from Section 4.3 about the basic idea of the system. To increase the flexibility, the system should be independent of document format and document location. One nonfunctional requirement that is a logical result of the keyword problem discussed in Paragraph 4.4.1 is that one language should be determined to use in the system. The use of only one language reduces the number of potential keywords.

Summarizing, the nonfunctional requirements of the reference selection system are:
- The system should be supported by the users worldwide.
- The system should contain as much references as possible from all over the world.
- The system should provide a single point of access to all references worldwide.
- The system should contain some security measures.
- The system should be independent of reference document format.
- The system should be independent of reference document location.
- The system should be in one single language.

<u>4.4.3 Performance requirements</u>
Performance requirements indicate what qualities a delivered service should have. The standard performance requirements are (Thiadens, 2005; Yang et al, 2005):
- Effectiveness of the system: it should be able to link the system to the existing information systems. Furthermore, the system should guarantee secure knowledge exchange.
- Adequacy of knowledge: the system should guarantee reliable and complete knowledge exchange without faults.
- Practicability or usability: the system should be easy to operate (user friendly), there is no need for special equipment at the user and there is no or a minimal need for training to learn to work with the system. Descriptions of new references should be easily added to the system's reference library and updating should be simple.
- Efficiency: the system should have no delays in processing the requested and offered knowledge. It should efficiently help the user in deciding which references are most suitable for the proposal.
- Reliability of the system: the system should be always available.
- Maintainability: the system should need minimal maintenance and it should be feasible to correct possible errors in the system as easy as possible. The user rights should be easy to manage.
- Portability: if Capgemini gets a new information system, it should be able to migrate the system to the new information system without the need for any adaptations to the system.

These standard performance requirements are all applicable to the system build during this graduation research.

4.5 Four descriptive views: ARIS

The objective of the ARIS (Architecture of Integrated Information System) methodology is to facilitate the specification and implementation of information systems that support business processes. This methodology is thus well suitable to overlook the Reference Tracking System. The ARIS methodology consists of four different views (function, data, organization and control view) and three levels (requirement definition, design and implementation) (Heib et al, 1996). This is shown in Figure 16.

In this section the system is viewed from the four views that are part of the ARIS methodology: function, data, organization and control. This is done using a function tree for the function view, an Entity-Relationship Diagram for the data view, organizational charts for the organization view and event-driven process chain diagrams for the control view.

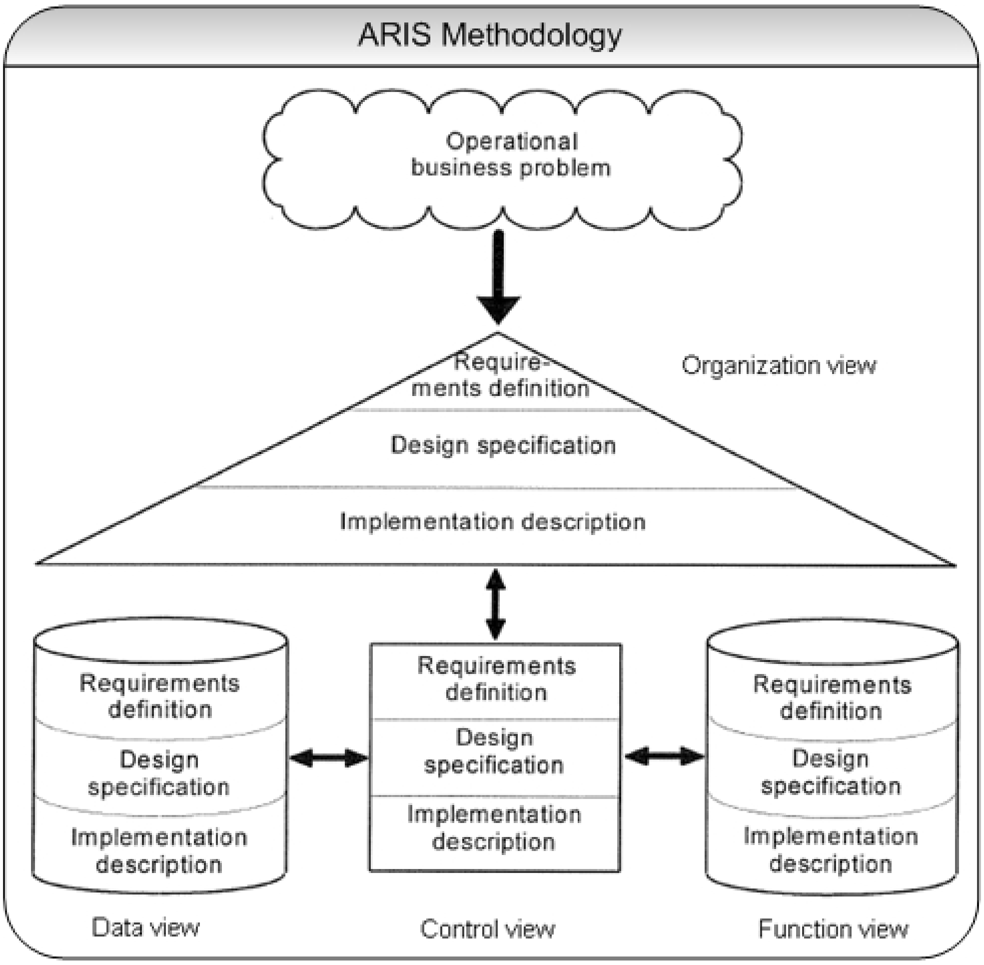


Figure 16: ARIS methodology (Heib et al, 1996; Scheer, 1994)

4.5.1 Function view

The functionality of the Reference Tracking System can be divided into three groups: the matching mechanism, content management of the reference library and user management. These three function groups and their sub functionality are illustrated in Figure 17. The rounded rectangles represent the different functions of the Reference Tracking System.

Three sub activities can be distinguished within the matching mechanism: the input of selection criteria, the calculation of the hit rate and the presentation of the shortlist with suitable references. The user of the system has to insert the selection criteria the reference he is looking for should satisfy. This is an interaction of the user with the Reference Tracking System. When the user has inserted all search criteria, the system starts calculating the hit rate of all references in the reference library. The hit rate of a reference indicates the match between that reference and the search criteria inserted by the user. When all hit rates are calculated, the references are sorted and the references with the highest hit rates are presented to the user in the form of a reference shortlist. The last two sub activities – that are colored gray in Figure 17 – are automatic functions, although the result of the last sub activity is presented to the user.

The reference library contains all the details regarding the references. Three separate reference library content management activities can be distinguished: a new reference can be added to the reference library, some details of a reference can be modified and an old reference can be deleted from the reference library.

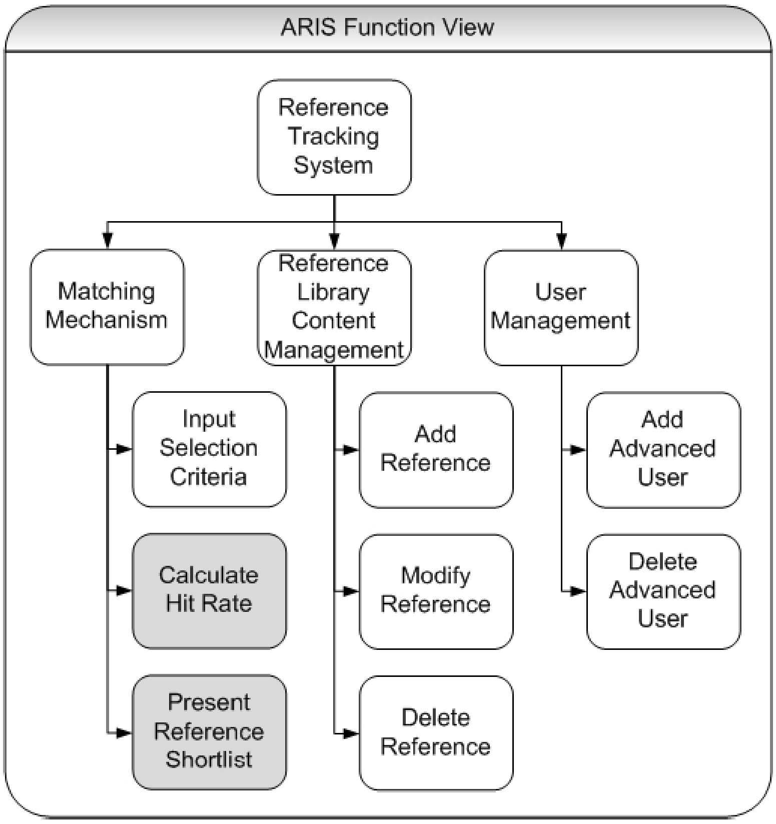


Figure 17: Hierarchy diagram of the functions within the Reference Tracking System

Only advanced users are allowed to add, alter and delete references. Some user management is needed to assign advanced user rights to users and to delete advanced users when they have become obsolete. Basic users are not registered in the system: all users within the Capgemini network can use the system.

4.5.2 Data view

The reference library contains all keywords and other terms describing the different contracts (hereinafter called descriptors) and the links to the reference documents. The content of this reference library determines largely the possibilities of the reference selection system and the result of a search task. Two factors influence the possibilities of the reference selection system: the number of references in the library (the number of rows in the database table) and the different descriptors that describe a certain reference and can be defined during a search task (the number of columns in the database table).

In this paragraph the different descriptors in the reference library are discussed. These descriptors determine largely how well a suitable reference can be found. The demands that references should comply with are quite diverse, depending on the customer's wishes. Furthermore, the sales team can determine further search criteria to get a better match between the situation at the client's and the situation described in the reference. All these descriptors should be covered in the reference library. The different descriptors in the reference library form an interconnected whole.

This can be illustrated using an Entity-Relationship Model. An Entity-Relationship Diagram is an abstract conceptual representation of structured data. In an Entity-Relationship Diagram three types of blocks can be distinguished: rectangles, diamonds and ellipses. A rectangle represents an entity. An entity can be defined as a thing that exists independently of other things and that can be uniquely identified. A diamond represents a relationship between two entities. An ellipse represents an attribute, a property of an entity or relationship (Romney & Steinbart, 2003). The Entity-Relationship Diagram regarding the data fields in the reference library is shown in Figure 18. For a better view, a full page version of this diagram is included in Appendix B.

The numbers near the lines between an entity and a relationship represent the cardinality of the relationship. Cardinality defines the numeric relationship between the entities on either end of the relationship line (Data Model, 2005; Romney & Steinbart, 2003). In the Entity-Relationship Model four types of relationships can be distinguished. These are explained in Table 3.

In the Entity-Relationship Model several entities are shown. These entities and their attributes are explained in the data dictionary in Table 4.

Of each reference all these descriptors should be determined and included in the reference library. Some descriptors have only some possibilities. A list of sectors and industries, disciplines, offers and sub offers, regions and confidentiality levels is included in Appendix A. A list of the alliance partners, key technologies and other keywords that are currently distinguished is included in Appendix C.

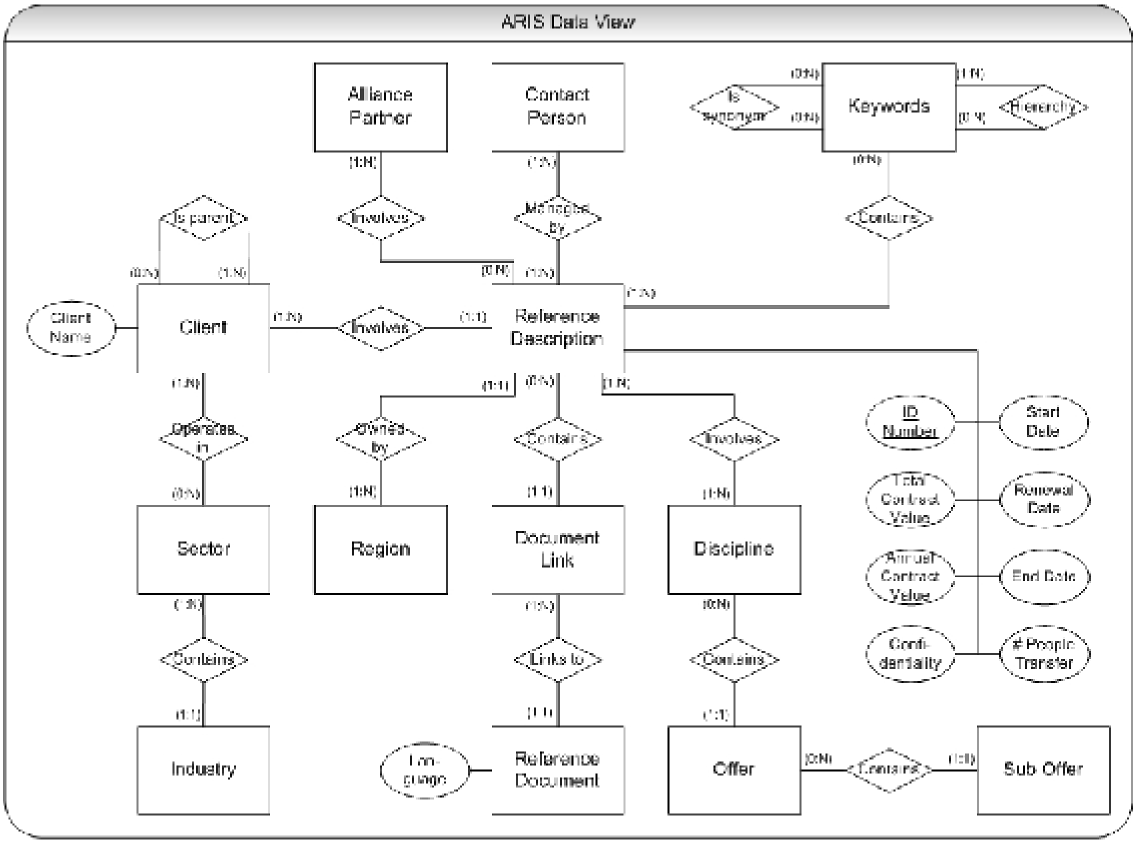


Figure 18: Entity-Relationship Diagram of the content of the reference library

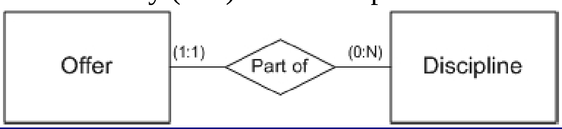
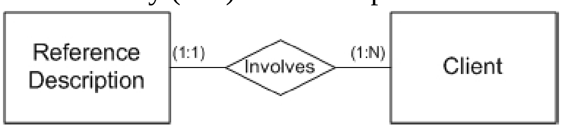
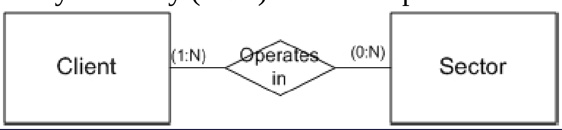
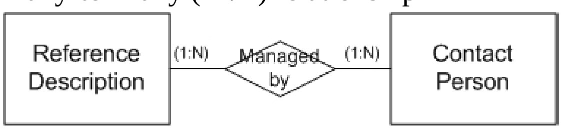
Relationship	Explanation
One-to-Many (1:N) relationship 	An offer (service line) is part of exactly one discipline, but a discipline may contain zero, one or many offer lines
One-to-Many (1:N) relationship 	A reference description deals with the contract of exactly one client, but a client can be part of one or more reference descriptions
Many-to-Many (M:N) relationship 	A client operates in at least one industry sector, but a sector can contain zero, one or more clients of Capgemini
Many-to-Many (M:N) relationship 	A reference description is managed by one or more service managers and each contact person is responsible for one or more reference descriptions

Table 3: Relationships used in the Entity-Relationship Diagram

Entity with attributes	Explanation
Reference Description ▪ ID Number ▪ Total Contract Value ▪ Annual Contract Value ▪ Start Date ▪ Renewal Date ▪ End Date ▪ Confidentiality ▪ # People Transfer ▪ Key Technologies ▪ Other Keywords	A unit in the reference library describing a contract ▪ A unique number identifying the referent in the reference library ▪ The contract value (excluding VAT) during the total contract period ▪ The contract value (excluding VAT) during one year of the contract ▪ The date the provision of services starts ▪ The date the contract is reviewed and renewed ▪ The date the provision of services ends ▪ The client has to give permission to use the reference: this field indicates the permission level ▪ The amount of people that become an employee of Capgemini as part of the contract ▪ The main technologies (both hardware, software and programming languages) that are used during the contract ▪ Other keywords that describe the activities performed during the contract, customer's targets
Client ▪ Client Name	The referent that hired Capgemini to take care of (a part of) the information technology
Parent ▪ Parent Name	If the referent is part of a greater group, the name of that group
Sector	The sector the client is active in
Industry	A sector is divided in several industries
Region	The region of Capgemini that is contract owner
Alliance Partner	Sometimes Capgemini collaborates with other organizations to deliver the requested services to the referent
Contact Person	A service manager responsible for the contract; he can provide contract information
Document Link	A link to a knowledge repository, web page or folder that contains reference documents
Reference Document ▪ Language	An extensive description of a reference ▪ The languages in which reference documents are available
Discipline	A key area of Capgemini that is involved in the service provision to the referent
Offer	A delivery department of Capgemini Outsourcing that is involved in the service provision to the referent
Sub Offer	A sub department of a delivery department of Capgemini Outsourcing that is involved in the service provision to the referent

Table 4: Data dictionary regarding the Entity-Relationship Diagram

4.5.3 Organization view

The Reference Tracking System is a system that should be used within the Sales departments of the different regions of Capgemini Outsourcing. The ultimate goal is that its use is extended to the Technology and Consultancy disciplines of Capgemini, but within this graduation research study only Capgemini Outsourcing Netherlands is taken into account. The organizational chart of Capgemini Outsourcing Netherlands is shown in Figure 19.

Capgemini Outsourcing Netherlands consists of four departments and some support departments. Three of these departments (Application Management, Infrastructure Management and Retail Solutions) are delivery departments, also called service lines or offers. They are responsible for the service provision towards customers. The Infrastructure Management service line can be divided into Data Center Services and Desktop & Distributed Services. Retail Solutions is the result of the recent acquisition of Maxeda ITS (the information technology department of former Vendex KBB) and is a separate department of Capgemini Outsourcing Netherlands. The service managers that provide information about referents are members of the delivery departments. The Sales department is responsible for winning bid trajectories to secure new customers. In this department the reference selection system will be mainly used. Therefore, the focus is on the employees of the Sales department. The Sales department is further explored in Figure 20.

The Sales department consists of two main groups of employees: the sales force and sales support. The sales force consists of sales managers, responsible for customer contact. Sales support employs personnel that support bidding trajectories. Knowledge management is a supporting group within sales support. The users of the reference selection system are the employees of the sales force and sales support.

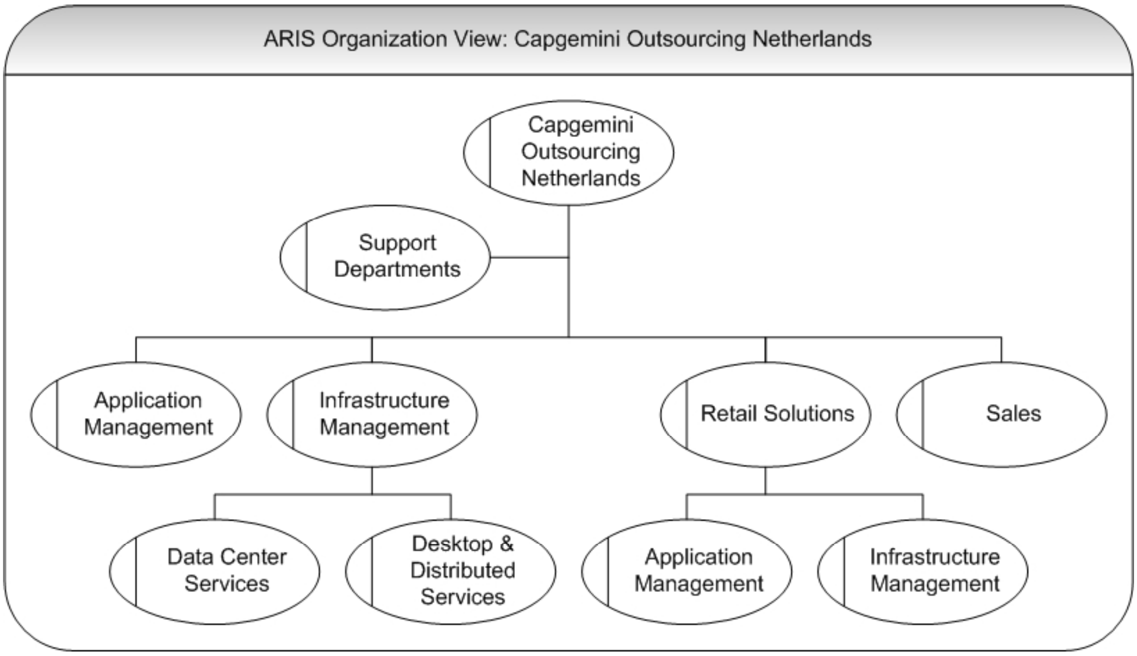


Figure 19: Organizational chart of Capgemini Outsourcing Netherlands

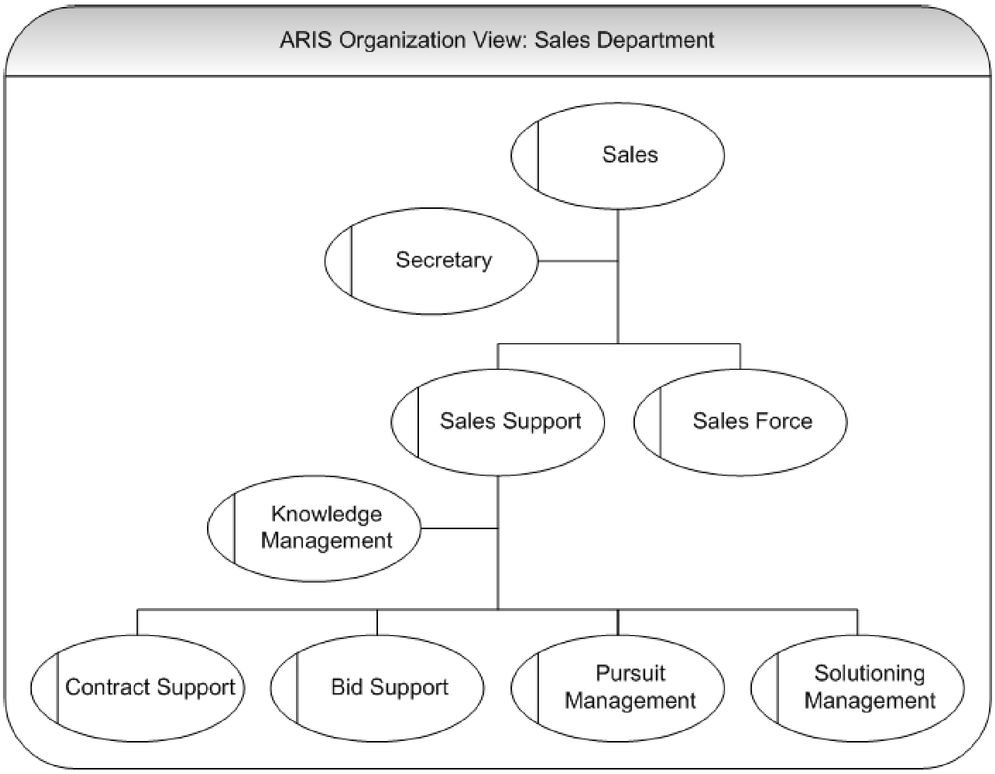


Figure 20: Organizational chart of the Sales department

When the common tasks of the different users are taken into account, the users can be divided into two user roles: basic users and advanced users. The basic users only have to search for references. They have no rights to add, modify or delete references. The advanced user role has the right to add, alter and delete references. They are responsible for the references that origin from their region. The advanced user group consists of the bid support employees and knowledge management. All other personnel of the sales department get the basic user role, but mostly the sales managers and pursuit managers will use the system.

The system is developed by the knowledge management group within sales support. The developers are the ones who build the system and who implement changes. The developer will also be the administrator of the prototype of the artifact.

4.5.4 Control view

The main functionality of the Reference Tracking System is the reference selection functionality (matching mechanism, see Figure 17). The other functions are support functions meant to update the reference library and add or delete users. In this paragraph event-driven process chain diagrams of the reference selection process and the three reference library content management processes are presented.

In an event-driven process chain diagram three building blocks can be distinguished: rounded rectangles, hexagons and XOR circles. Just like in the function chart (Figure 17), the rounded rectangles represent functions. Functions are the active elements of the event-driven process chain diagram. When a function is finished an event occurs. These events are represented in an event-driven process chain diagram by hexagons. An event is a passive element that describes a certain circumstance at which moment a next activity should be performed. A XOR represents a branch or a merge in the decision path. A branch has one incoming control flow and two or more outgoing control flows. When the condition is fulfilled, a branch activates one of the outgoing control flows. A merge is the opposite of a branch. A merge has two or more ingoing control flows and one outgoing control flow. When one of the incoming events occurs, the outgoing control flow is activated (Scheer, 1994).

In Figure 21 the event-driven process chain diagram of the reference selection process is shown. In the reference selection process two actors are involved: the sales employee that uses the system and the Reference Tracking System. The sales employee can be anyone within the sales department or even another Capgemini employee, who needs a reference.

The reference selection process starts when there is the need for a reference. The user inserts the search criteria. When all criteria are filled in and the user gives the order to calculate the hit rates, the system starts calculating the hit rates of all the references in the reference library. The hit rate of a reference is defined as the match between the details of that reference and the search criteria. When all the hit rates are calculated the system sorts the references starting with the reference with the highest hit rate. When the references are sorted a shortlist is created by the system. This shortlist is presented to the user of the system, who has to evaluate the shortlist. When the shortlist contains too much or too few references that seam suitable, the user has to refine his search criteria. The reference process starts again. This is shown in the event-driven process chain by the feedback loop. When the shortlist contains an appropriate reference, the user selects that reference and the reference selection process is finished.

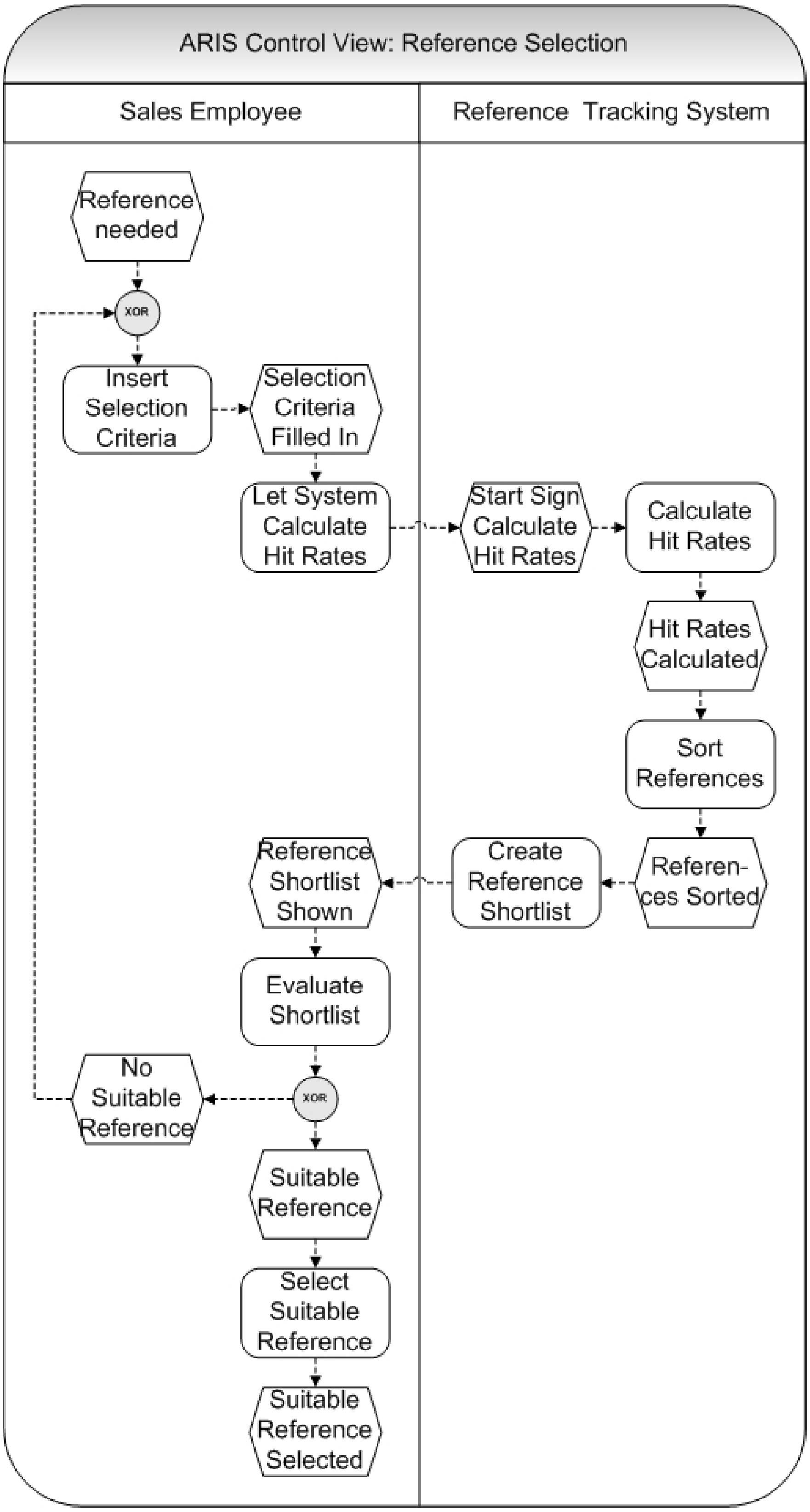


Figure 21: Event-driven process chain diagram of the reference selection process

In Figure 22 the event-driven process chain diagram of the add reference process is shown. In the add reference process three actors are involved: the basic user role, the advanced user role and the Reference Tracking System. Basically, the basic user role and the advanced user role are performed by the same employee, who starts the system as a basic user, but receives the advanced user role when he has logged in.

When a sales employee receives a new reference, he logs in with his username and password and indicates that he wants to add a reference by opening a new reference template – a field in which he can fill in all reference details. An empty reference template opens. The user fills in all details regarding the reference, like client name, contact person, industry sector, key technologies used and so on.

When the user has filled in all reference details and orders to save the reference, the Reference Tracking System checks whether all mandatory fields are filled in. If some mandatory fields are left open, the system colors these fields red and shows an error. The user

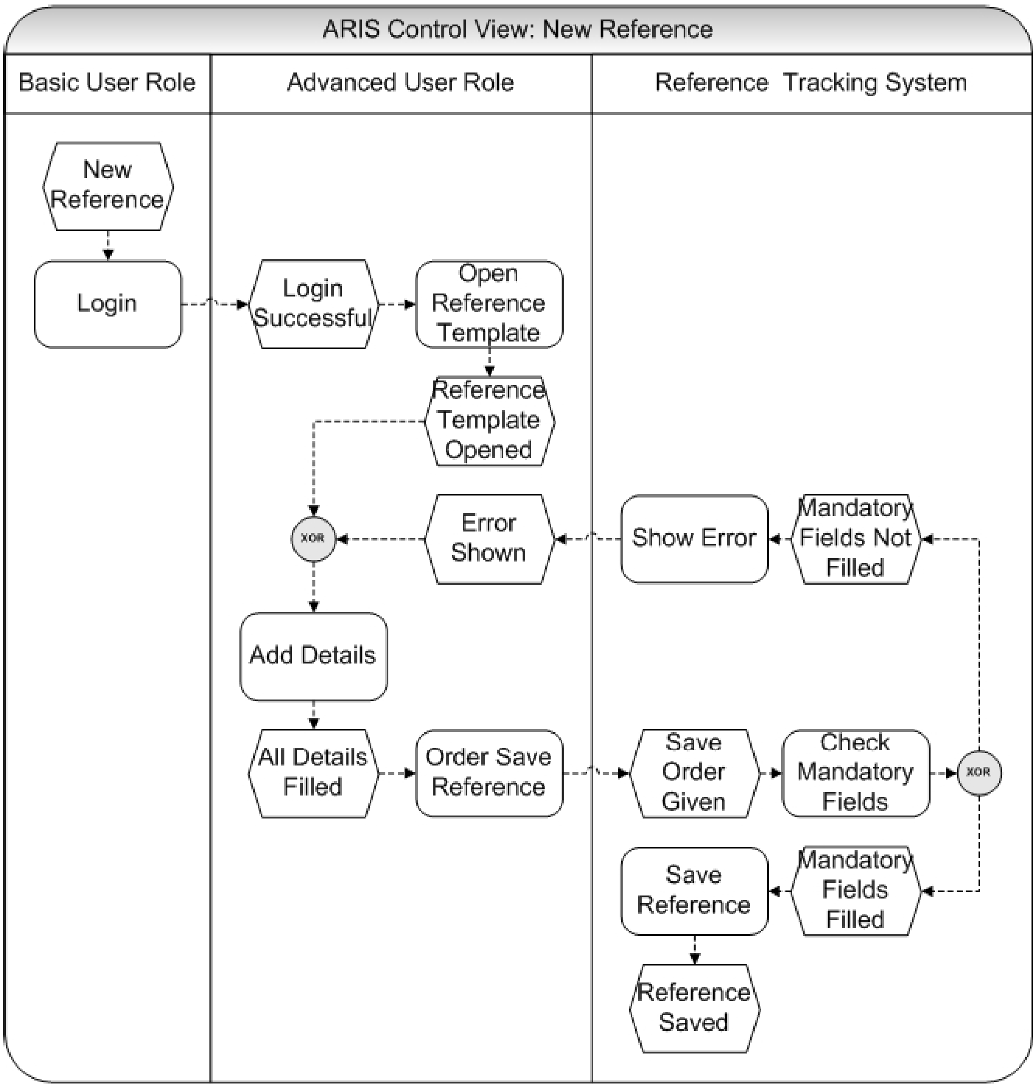


Figure 22: Event-driven process chain diagram of add reference process

has to fill in these fields, before the reference can be saved. When all mandatory fields are filled, the new reference is saved in the reference library.

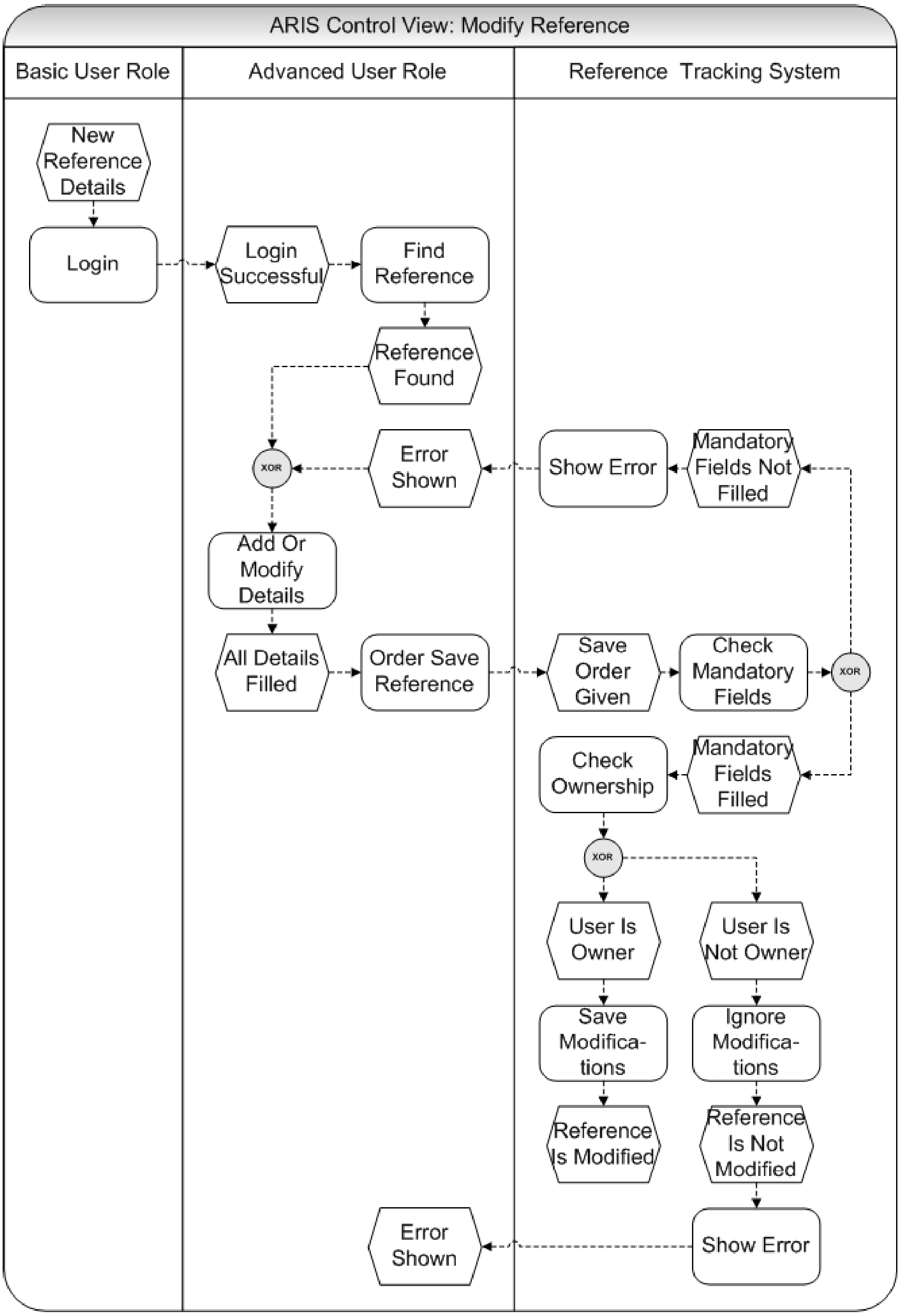


Figure 23: Event-driven process chain diagram of modify reference process

In Figure 23 the event-driven process chain diagram of the modify reference process is shown. The same as in the add reference process, there are three actors involved in the modify reference process: the basic user role, the advanced user role and the Reference Tracking System.
When a user receives new details regarding an existing reference, he logs in with his username and password and searches the reference he wants to modify. When the reference is shown the user adds the new details or alters the details that are changed.
When the user has changed the reference details and orders to save the reference description, the Reference Tracking System checks whether all mandatory fields are filled in. If some mandatory fields are left open, the system colors these fields red and shows an error. The user has to fill in these fields, before the reference can be saved.
When all mandatory fields are filled in, the Reference Tracking System checks whether the user is the owner of the reference description. When this is the case, the reference is saved in the reference library. When the reference description is owned by another user the modifications are ignored by the Reference Tracking System and the modifications are not saved. The Reference Tracking System shows the error to the user that he is not allowed to modify the reference description, because he is not the owner.

In Figure 24 the event-driven process chain diagram of the delete reference process is shown. The same as in the add reference process and in the modify reference process, there are three actors involved in the delete reference process: the basic user role, the advanced user role and the Reference Tracking System. Basically, the basic user role and the advanced user role are performed by the same employee, who starts the system as a basic user, but receives the advanced user role when he has logged in.
When a user receives the message that an existing reference can no longer be used in bid trajectories, he logs in with his username and password and searches the reference he wants to delete. When the reference is shown, the user orders the deletion of the reference.
When the deletion is confirmed by the user, the Reference Tracking System checks whether the user is the owner of the reference description. When this is the case, the reference description is deleted from the reference library. When the reference description is owned by another user the deletion is ignored by the Reference Tracking System and the deletion is not saved. The Reference Tracking System shows the error to the user that he is not allowed to delete the reference description, because he is not the owner.

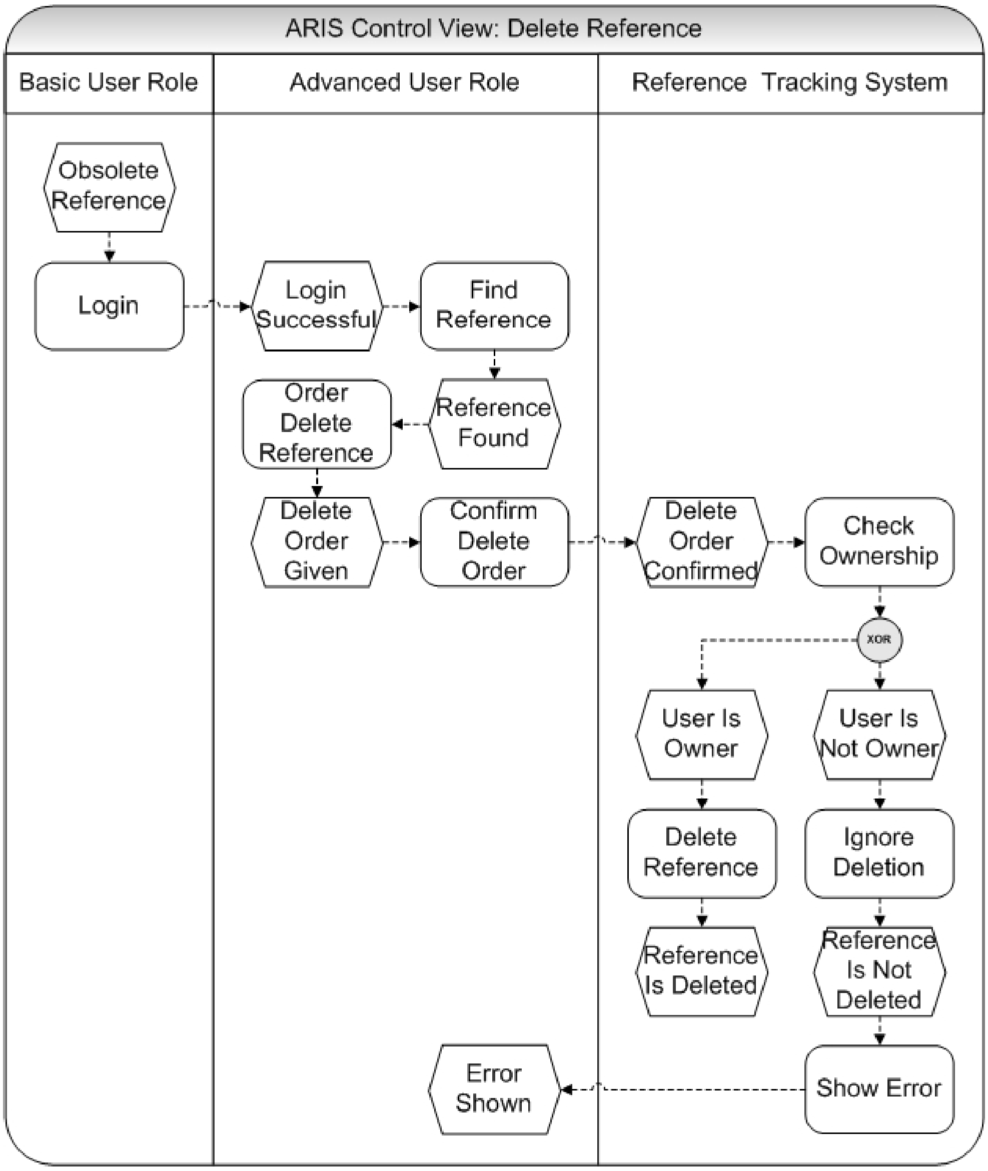


Figure 24: Event-driven process chain diagram of delete reference process

5. Development of the Reference Tracking System

This chapter discusses the development of the Reference Tracking System that targets the requirements determined in the previous chapter about the design of the reference selection system. As shown in the function diagram, the system has three main functionalities. Furthermore, it consists of a reference library that forms the base of the system. This chapter discusses how the reference library and the three functionalities should be developed.

5.1 The reference library

The reference library is a database that contains all keywords and other terms describing the different contracts and the links to the reference documents. As discussed in Paragraph 4.5.2 the efficiency of the reference selection system largely depends on the content of the reference library. Furthermore, the setup of the system is very important for the functionality.
Advanced users have the right to add new references to the reference library and alter and delete old references available within the library. These changes should become available to all users. Therefore, all users should share the content of the reference library.
This sharing can be done in two ways: the users can have their own local reference library that is synchronized with a master database on a regular basis or all users can use the same centralized case library.
The first possible system, in which the local database is synchronized with a master database, needs security measures that make sure that new or modified content in the database is not overwritten by old content. When a user modifies a certain reference, these modifications should be carried out in the master database and in all the local reference libraries of other users. Guaranteeing reliability of database content can be quite an intricate problem. Especially when two users are modifying the same reference at the same time, a problem arises. To decrease or even prevent this issue, the changes in the database content should be available in the master database and in other users' database files as soon as possible and preferably real-time.
When the databases are updated real-time, the local databases can better be replaced by a centralized reference library that all users utilize (Kanitkar & Delis, 2002). All the modifications users make are immediately available to all users. By saving separate database fields instead of entire database entries (complete reference descriptions) the problem of simultaneously altering references by different users can be minimized.

The reference library is a database. This database can be of different database types. The reference library could be stored in a simple text file and in a relational database, for example an Access database, a MS SQL database or a XML database.
The comma separated text file is very simple. It includes no functionality to protect the data in it and it is hard to manually alter the information due to the inconvenient arrangement of the information, although this can be improved by converting the text file in an Excel sheet. A text file based database is well suitable for the prototype of the reference selection system, but not to create the reference library of the final system. For the sake of simplicity the

database of the prototype is a comma separated text file. In the final system this should be replaced by a relational database.
SQL means Structured Query Language. It is a database computer language designed for the retrieval and management of data in relational database management systems. It is the most used database programming language that is often used in very complex, intertwined databases. Furthermore, there are other relational database types like a XML database. When the prototype build during this graduation is converted into the final system, I suggest that the reference library would be placed in one of these relational database types.

5.2 The matching mechanism

The matching mechanism is the most important part of the system. It calculates the hit rates of the different references given the search criteria inserted by the user. The hit rate of a reference is defined as the match between the details of that reference and the search criteria inserted by the user expressed in percents. The references with the highest scores are presented to the user. The matching mechanism performs the knowledge selection. The matching mechanism consists of three parts: the search screen, the hit rate calculator and the presentation shortlist.
In the search screen the user can insert the requirements the references should satisfy. The user could define all descriptors discussed in Paragraph 4.5.2, except from the confidentiality levels of the references and the document sources (document links and contact persons), because a search for these terms would be useless. Besides, a user should be able to search for contracts with a certain contract length.
When the user performs the search task, the system should calculate the hit rate of each reference. The hit rate calculator is a case of multiple criteria decision making. Multiple criteria decision making refers to making decisions in the presence of multiple, usually conflicting criteria (Roy, 1990; Zanakis et al, 1998). The selection criteria the user inserts in the system are the multiple attributes. The decision that has to be made using these criteria is which references are most appropriate or in other words satisfy the selection criteria best.
Two types of multiple criteria decision making can be distinguished: multiple attribute decision making and multiple objective decision making (Holt et al, 1994; Zanakis et al, 1998). Multiple objective decision making is the probabilistic case of multiple criteria decision making. In this case the values of the different criteria are viewed as random variables. The values of the criteria are thus not unambiguously defined. Moreover, multiple objective decision making concerns with an infinite or large number of choices. This is not the case in this graduation assignment.
Reference selection is an example of multi-attribute decision making. Multiple attribute decision making or multi-attribute analysis is the deterministic case of multiple criteria decision making. In multi-attribute decision making there are a discrete, usually limited number of alternatives (the references in the library), requiring comparisons between attributes (the reference details) and involving tradeoffs between these requirements (which selection criterion is more important). In multi-attribute analysis the values of the selection criteria can be exactly defined (Holt et al, 1994; Roy, 1990; Zanakis et al, 1998).

Several different methods are available in multi-attribute decision making (Zanakis et al, 1998). The most commonly used are the additive model (also called general additive form) and the linear model (also called weighted sum and simple additive weighting). These are compensatory methods, meaning that a low score on one criterion can be compensated by high a score on another criterion. By giving a certain criterion a very high weight compared to the other criteria, this criterion becomes non-compensatory, so a suitable alternative should at least satisfy this criterion. The additive and the linear model can be expressed in a mathematical form (Holt et al, 1994):

Additive model: $Score_j = \sum_{i=1}^{n} V_{ij}(x_i)$

Linear model: $Score_j = \sum_{i=1}^{n} V_{ij} W_i$

In these models the following notations are used:

- i: search criterion number;
- j: reference number;
- n: the amount of references available in the reference library;
- $Score_j$: total score of reference j considering all search criteria;
- $V_{ij}(x_i)$: score of reference j considering search criterion i as a function of the elements x_i;
- V_{ij}: score of reference j considering search criterion i;
- W_i: weight of search criterion i.

From research by Zanakis and his colleagues (1998) it appeared that when the number of alternatives (the number of references in the reference library) increase, all methods used in this research tend to give ranks close to the weighted sum method. The research study by Zanakis and colleagues was performed with three to nine different alternatives. Compared to this amount the number of references in the reference selection system (currently 137) is very large. Therefore, the linear model, that is popular among practitioners due to its simplicity (Zanakis et al, 1998), is well suitable to use as reference selection method in the Reference Tracking System.

The different weights of the search criteria W_i can be set all equal or each selection criterion can have its own weight (Zanakis et al, 1998). The first option, same weights for all criteria, has the advantage that it is very simple for both the developer of the system and the users. However, Zanakis et al (1998) concluded that equal criterion weights reduce the difference between the total scores of different alternatives. This complicates the selection of suitable references. Moreover, the question is if all criteria are even important. For example, a key technology is more important than the industry sector an organization operates in. When a reference is needed for Siebel CRM management within a high tech production company, a reference of Siebel CRM management within a financial institution may be appropriate, while SAP management within a high tech organization is not. Therefore, the reference of the Siebel CRM management within the financial company should have a higher hit rate than the

SAP management within the high tech organization. It is clear that this option is not the most appropriate matching mechanism because of its limitations.

The other weighting model is an unequal weight for the different selection criteria. The developers of the Reference Tracking System have to determine the importance of each selection criterion in the total score or in other words the weight of the criterion. Using this system the difference between total scores of different alternatives is in general larger than with the equal weighted method. There is no difference in ease of use of the system, because the hit rate calculator is not visible for users. By implementing a well-thought-out weight distribution based on the vision of the future users of the system, the weighted sum method with unequal criterion weights is the best option because the importance of the different selection criteria are taken into account.

The result of the selection mechanism is a list of all the references including a hit rate that indicates the match between the search criteria and the reference details. A score of 100 % implies that the reference satisfies all selection criteria, while a reference with no similarities gets a hit rate of 0 %. The references with the highest scores should be presented to the user of the system. The higher the hit rate, the higher the reference is listed.

A search task in a search engine like Google results sometimes in thousands of results. This limits the usefulness of the search result, because useful results can be hidden in less useful results. Such functionality is not desired, so a maximum number of twenty references is presented. A user can survey a list of twenty references, while the result is not too limited to exclude potentially useful references. Only references with a hit rate higher than 67 % are shown, because references with lower scores can be considered useless. The percentage is the result of a series of search tasks in which the usefulness of the returned results in the reference shortlist is assessed. The conclusion of this assessment was that references with a hit rate lower than 67 % can be considered useless, while references with a score of 67 % or higher match enough selection criteria to be potentially useful.

The essentials of the matching mechanism can be expressed in pseudo code.

```
For all search criteria filled in, do:
        Total points is increased with the positive weight of the search criterion.
        For all references in the system, do:
                If the search criterion is matched:
                        Score of reference is increased with the positive weight of the criterion
                Else:
                        Score of reference is increased with the negative weight of the criterion
For all references in the system, do:
        Calculate hit rate by dividing the score of reference by the total points
Sort all references in the system by the hit rate
For the first 20 references in the sorted list, do:
        If hit rate is higher than 67 %, do:
                Present reference in shortlist
```

This pseudo code forms the basis of the matching mechanism of the Reference Tracking System. A selection criterion can have both a positive weight and a negative weight. A reference satisfying the selection criterion gains the positive weight and a reference that does not match the search criterion receives the negative weight. This is further explained in Paragraph 6.2.1.

5.3 Reference library content management

As stated in Section 5.1, the reference library is a database that contains all keywords and other terms describing the different contracts and the links to the reference documents. The content within the reference library is not static: new contracts can be concluded, contracts expire so the referent can no longer be used and contracts chance as a result of renegotiations and extensions. Therefore, the content of the reference library should be managed by advanced users.

One of the main issues regarding the management of the content of the reference library concerns the used keywords. Two types of keywords can be distinguished: key technologies and other keywords. Key technologies are the main technologies used in a contract. These can be hardware types as well as software systems and programming languages. The other keywords include the activities performed for the customer, the customer's targets and other relevant keywords. A list of keywords is included in Appendix C of this graduation report. Obviously, these keywords are quite diverse. Similar client goals can be defined using different phrases, many terms have synonyms and abbreviations and terms can be expressed in multiple languages. This problem is visualized in Figure 25. A keyword can have a relationship with another keyword in the sense that they are synonyms of each other. From a small-scale research study that cannot be generalized, it appeared that keywords defined by users are not very useful, because they introduce topics that were previously not under consideration (Taghva et al, 2004). Furthermore, one of the fundamental problems in information retrieval using keywords is word mismatch (Guo & Li, 2006). These are also problems for the Reference Tracking System, as is illustrated in Paragraph 7.3.2 in which a user searches for references using file and print, which is no keyword. To facilitate the selection process some common vocabulary should be defined in the Reference Tracking System (Gruber, 1993).

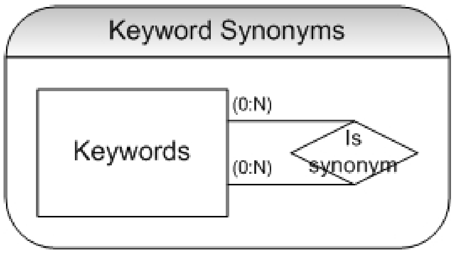


Figure 25: Keyword ontology

To solve the multi language problem all keywords should be in English, because English is the accepted business language in the Western World. The other problems are less easily solved. Due to time constraints during this graduation this problem is not solved in the prototype of the Reference Tracking System. In the prototype this problem is avoided by using a list of keywords (see Appendix C). This list can be used while searching for suitable references for bid trajectories and when adding new references to the reference library.

In the final system some countermeasure is needed to avoid the use of synonyms, what result in incomplete search results or to make sure that the system takes all synonyms into account.

This problem can be solved using a synonym table or by replacing the free text fields by combo boxes or topic trees.

A synonym table contains all keywords, including possible synonyms and abbreviations. Each time a search task is performed the system does not only check if the reference contains the keywords, but also if the reference contains one of the synonyms and abbreviations of that keyword. When a user searches for references that involves a wireless area network, the system does not only looks for references with the keyword wireless area network, but also for its synonym wireless LAN and the abbreviations WAN and WLAN, because these terms are mentioned in the synonym table. A major disadvantage of using a synonym table is that it is very hard or even impossible to create a complete synonym table, partly due to different notations of terms in British English and American English.

The other solution is using combo boxes or topic trees instead of free text fields. In a text field the user can enter any term he desires, but in a combo box or topic tree, the freedom is limited. By replacing the text fields by combo boxes or topic trees, the user can only select a predefined term. The working of combo boxes and topic trees is similar, but in a topic tree the keywords are categorized making it easier to find keywords. The disadvantage of this solution is that the combo box lists or topic trees needs to be maintained. Furthermore, the flexibility of the system and the user decreases. But the search performance increases, so I recommend using one of these in the final Reference Tracking System.

The second issue is the needed level of detail of the keywords, the taxonomy (Farbey et al, 1995). This issue is especially relevant in the case of key technologies. Many hardware and software providers sell products that are slightly different from each other, but with other names and types. The issue is whether the manufacturer name, the product name or the type should be used as keyword. This issue is visualized in Figure 26. Keywords can be part of a broader group described by another keyword and can be further explored.

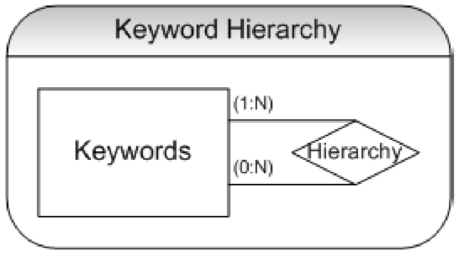


Figure 26: Keyword taxonomy

The next example illustrates this issue. A customer wants to outsource the maintenance of the ERP package SAP R/3 with the module Finance & Controlling. References using this package can be described at different levels of detail: ERP, SAP, SAP R/3 and SAP R/3 FI/CO. When in references only the keyword ERP is mentioned also Oracle, Siebel and Peoplesoft clients are returned, although only SAP references are requested. The usefulness of such system is quite low. But when a modules detail level is used, the list of possible keywords gets extended (for example SAP R/3 FI/CO, SAP R/3 MM, SAP R/3 SD, SAP R/3 PM and so on). Such extended list gets obsolete quite soon, because the list should be updated each time new modules and versions are released. This reduces the maintainability of the system. It is clear that the level of detail of the keywords describing a reference largely determine the usability of the system.

No unambiguous answer is possible on the needed level of detail of the key technologies. In this graduation assignment, mostly the manufacturer name or main product name is used as keyword, for example IBM, Oracle and Microsoft. This choice is based on a comparative assessment between usefulness and ease of use.

5.4 User management

Not all users should have the right to add, alter or delete references. Most users have the basic user role and only have to search for suitable references for responses to requests. To make a distinction between basic and advanced user roles some security measures should be included in the system. Without any security measures all users have the right to add, alter and delete references – the advanced user role. This may cause a proliferation of references and can be danger for the quality of the references in the case library. Moreover, a reference should be in the system once. Therefore, every reference should have an owner who is responsible for keeping the reference up-to-date. This owner can be a person, but also a role or a representative of a region.

The most easy security measure is to give all reference owners a login consisting of a user name and a password. When a user logs in he gains the advanced user role and is able to add new references and modify and delete old references that he previously added. This security setup has the disadvantage that it is very rigid: only one user (except from the administrator) can alter and delete a reference. In the prototype, this is not a major problem, so in the prototype only the creator of the reference has owner rights.

This rigidity can be reduced by giving all representatives of a region the right to alter and delete references originating in that region. Therefore, all owners should be connected to a region. This is recommended in the final system.

6. Implementation of the Reference Tracking System

This chapter describes how the designed and developed elements are implemented in the prototype of the Reference Tracking System. The system can be divided into two user levels. The level 0 application meant for the basic user role includes only the search functionality. A user can enter search criteria and perform a reference selection task. He can see the details of a reference and click further to the reference document. He cannot add, modify or delete references. For that purpose the level 1 application exists. Beside the basic functionality, an advanced user has the right to insert new references and to change and delete references he previously added to the case library. All the details regarding references are in the reference library.

The application is designed and developed by Vincent den Ouden and programmed in Visual Basic by his Capgemini colleague Peter Koning, who is a Visual Basic expert. His expertise in Visual Basic is the reason why the application was programmed in this programming language.

First the reference library is discussed. Next, the level 0 and level 1 application are presented.

6.1 The reference library

As stated in Section 5.1, the reference library is a centralized database that contains all the details of the references. Currently, the database contains the details of 137 references. The ultimate goal of Capgemini is to create a system that gives access to all references from all disciplines of Capgemini and originating from all regions.

At this moment the reference library contains mainly references with an outsourcing component in it. This is shown in Table 5. Outsourcing Services is not involved in only 6.5 % of the references. This is caused by the fact that the system was developed within the Sales department of Capgemini Outsourcing.

Disciplines involved	Number of references	Percentage
Only Outsourcing Services	96	70.1 %
Only Technology Services	8	5.8 %
Only Consulting Services	1	0.7 %
Outsourcing Services and Technology Services	22	16.1 %
Outsourcing Services and Consulting Services	2	1.5 %
Technology Services and Consulting Services	0	0.0 %
All disciplines	8	5.8 %
Total	**137**	**100.0 %**

Table 5: Disciplines involved in the references in the reference library

Region	**Number of references**	**Percentage**	**Annual contract value < 5 M€**	**Annual contract value > 5 M€**
Asia Pacific	0	0.0 %		
Benelux	112	81.8 %	86.6 %	13.4 %
Central Europe	2	1.5 %	50.0 %	50.0 %
France	5	3.6 %	60.0 %	40.0 %
Iberia	1	0.7 %	0.0 %	100.0 %
Italy	1	0.7 %	100.0 %	0.0 %
Nordic	6	4.4 %	20.0 %	80.0 %
North America	4	2.9 %	25.0 %	75.0 %
UK & Ireland	6	4.4 %	16.7 %	83.3 %
Not Benelux	**25**	**18.2 %**	**33.3 %**	**67.7 %**
Total	**137**	**100.0 %**	**76.6 %**	**23.4 %**

Table 6: Origin and annual contract value of the references in the reference library

At this moment the reference library contains particularly references that originate from the Benelux. This is shown in Table 6. Only 18.2 % is coming from other regions. This implies that the visibility of references from other regions is still lacking. Moreover, most references from other regions have an annual contract value larger than 5 million Euros. Overall, three quarters of all references have an annual contract value of less than 5 million Euros, while only one third of the foreign references can be considered a minor reference. Because the references database contains almost all references from the Benelux, it can be concluded that most of the minor references from other regions are still missing. This illustrates the need for support and input from the other Capgemini regions to create a system that includes all assignments from Capgemini.

6.2 Level 0 application: basic functionality

When a user starts up the application, it automatically opens in the basic user mode. The user sees the screen shown in Figure 27. The system is made up of two tabs: Search and Result. The Search tab consists of the search screen of the application (the Problem field) and the shortlist that is presented when a search task is performed (the Shortlist field). The basics of these screens are described in Section 5.2. The second tab – Result – shows an overview of the selected record. The fundamentals of this screen are discussed in Section 5.3.
In this section the basic functionality of the Reference Tracking System is illustrated.

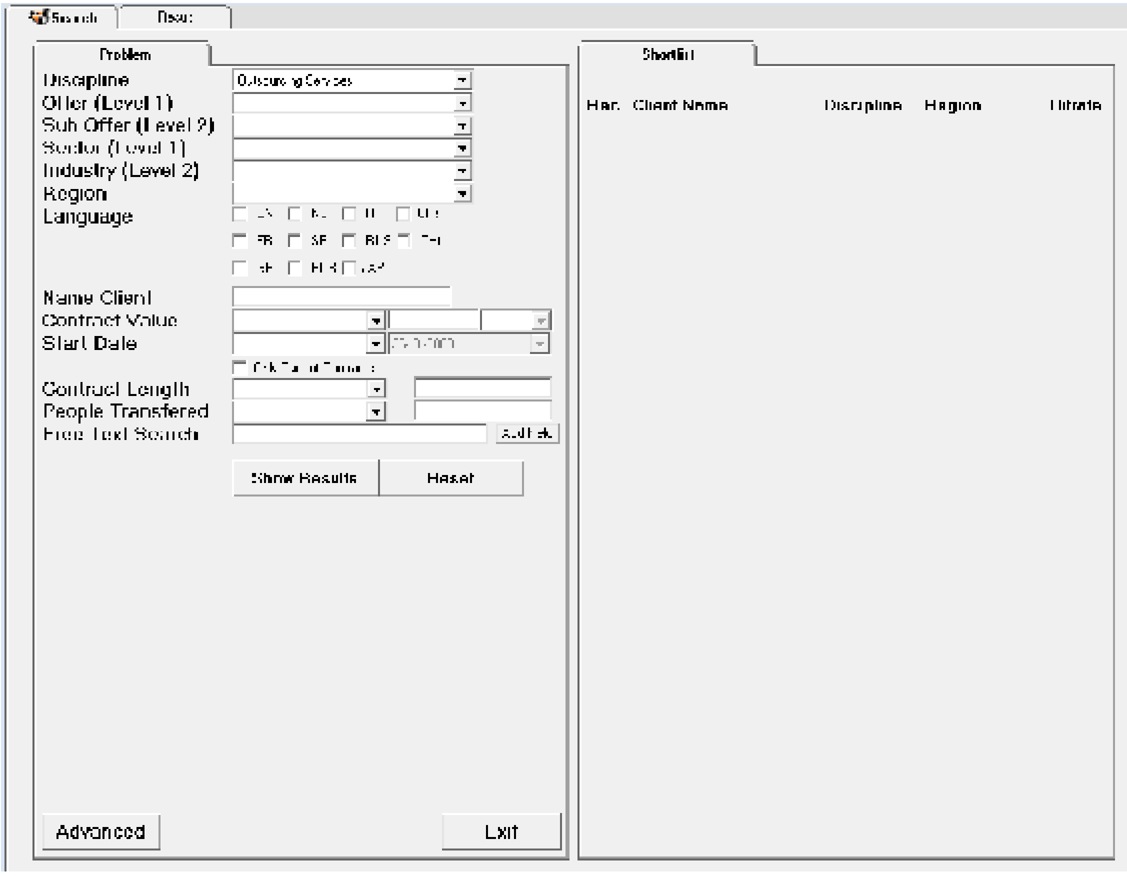


Figure 27: Start screen of the Reference Tracking System

6.2.1 The Search field

In the Problem field (shown in Figure 28) a user can define various search criteria. Most of the different fields in the reference library return and can be defined. In the Free Text Search fields a user can search for key technologies, other keywords and alliance partners. Both the Free Text Search fields and the Name Client field is capital insensitive, so SaP, sAp, sap and SAP give the same result. As already discussed in Section 5.2 each selection criterion has its own weight.

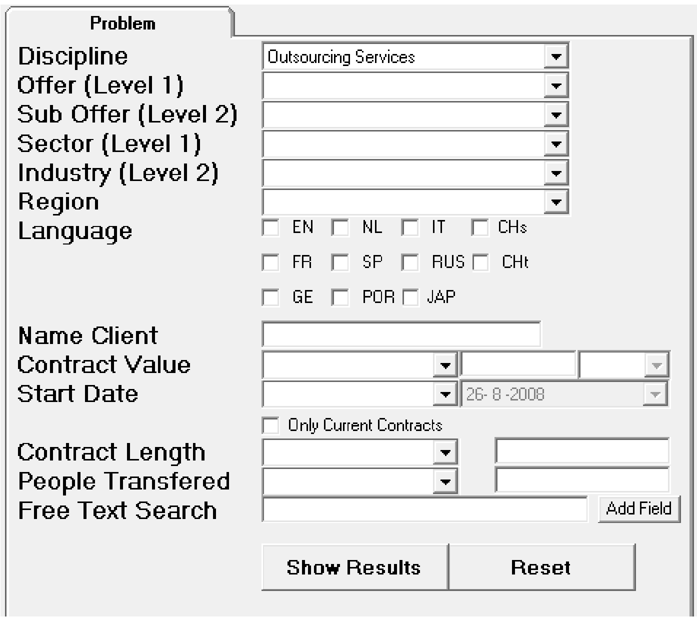


Figure 28: Problem field of the Search tab of the Reference Tracking System

The content of the Search field is the input of the matching mechanism. The matching mechanism calculates the hit rate of the references in the reference library. The matching mechanism is based on the pseudo code presented in Section 5.2.
In Table 7 the weights of the different fields are shown. A search criterion has both a positive weight and a negative weight. When a reference satisfies a selection criterion, it gains the positive weight. When a search criterion is not matched, the negative weight is gained. Most selection criteria have a weight value between 1 and 5 points. The more points are awarded the more important a criterion is. So Discipline is more important than Region and Region is more important than the Start Date of the contract. The same applies to the keywords in the Free Text Search fields. The first is considered more important than the second and the second has a higher weight than the other keywords. The impact of this weight division is illustrated in the example in Paragraph 6.1.3.
Two remarkable exceptions can be noticed. Name Client has a weight of 1000 points and a reference that does not match Only Current Contracts gets -100 points. A user who searches for customer name knows exactly what he needs. The system should return only references with the client name, because other references are not useful. When Only Current Contracts is checked, only contracts with an end date later than today are shown. A reference that matches the criterion gets 0 points, so this criterion does not influence the order of the presented references, but past references get a negative amount of points and are as a result of these negative points omitted in the search result.

Search criterion	Positive weight	Negative weight
Discipline	5	0
Offer (Level 1)	3	0
Sub Offer (Level 2)	1	0
Sector (Level 1)	4	0
Industry (Level 2)	2	0
Region	3	0
Language	1	0
Name Client	1000	0
Contract Value	1	0
Start Date	1	0
Only Current Contracts	0	-100
Contract Length	1	0
People Transferred	1	0
Free Text Search 1	5	0
Free Text Search 2	3	0
Free Text Search 3 - 10	1	0

Table 7: Weights of search criteria within Reference Tracking System

The references with the highest hit rates are presented to the user of the Reference Tracking System. Beside the customer name and hit rate, the shortlist of potentially suitable references shows the involved disciplines of Capgemini (Outsourcing Services, Technology Services and Consulting Services) and the region (for an overview of the regions of Capgemini see Appendix A) that owns the contract to make it possible to situate the references at a single glance. When you click on the client name, an overview of the reference is given in the screen that is also used to add, alter and delete references. This screen is discussed in the next paragraph.

6.2.2 The Result tab

When a user clicks on the name of a customer in the reference shortlist, the second tab opens. This tab – Result – shows an overview of the selected reference. In Figure 29 an example is shown. In the overview all columns from the reference table are shown except from the program fields. The ranking of this reference depends on the performed search task and is not show in this screen.

In the left top corner there are the different names by what the organization is known or was known including eventually the name of the parent organization. Underneath the responsible service managers (contact persons) are named. In the centre at the top, there are details regarding the contract (contract value, dates, number of people transferred) and the owning

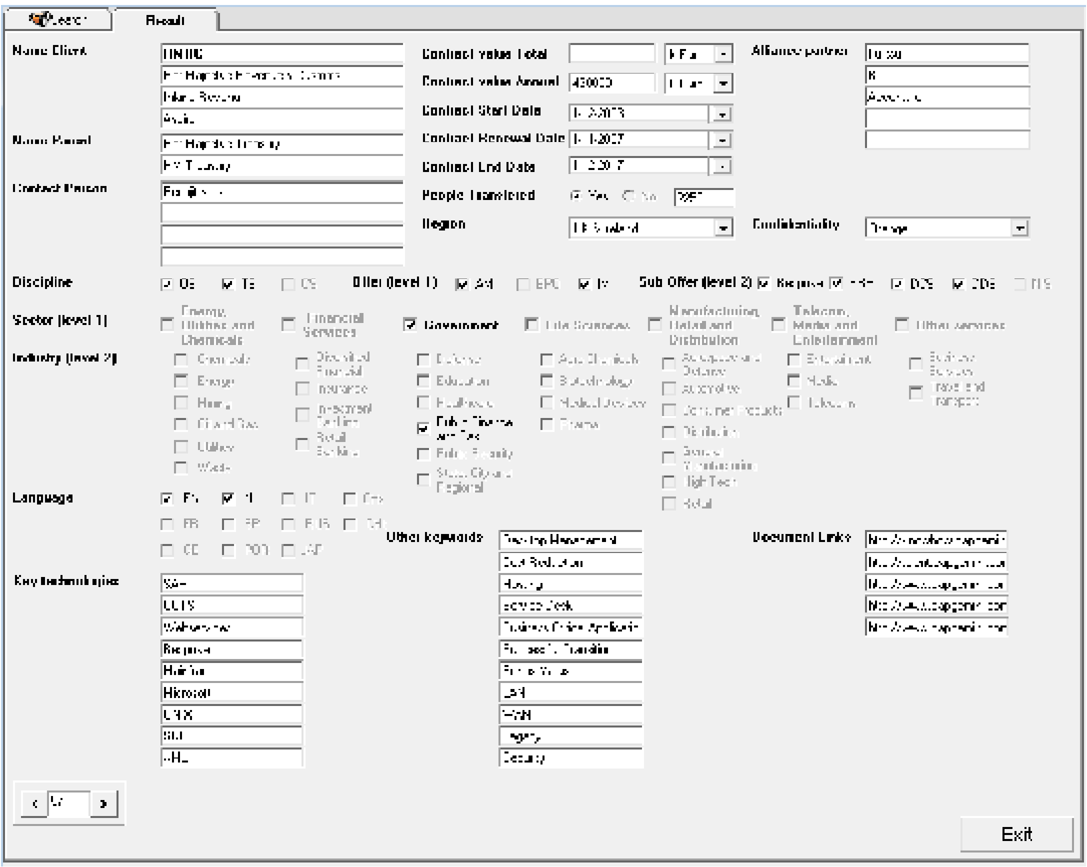


Figure 29: Result tab of the Reference Tracking System

region of Capgemini. In the right top corner any alliance partner is mentioned with underneath the confidentiality level of the contract. In the middle of the overview the involved disciplines and departments of Capgemini and the different industry sectors the customer operates in are marked. An organization can operate in more than one industry, which can be indicated by the user by selecting multiple checkboxes. For example, DSM operates both in the energy, utilities & chemicals sector (both oil & gas and chemicals) and in the life sciences sector (agro chemicals, biotechnology and pharma). At the bottom the languages of available reference documents are marked. Furthermore, the major technologies used, other keywords describing the contract and the location where reference documents can be found are shown. The document links are hyperlinks to the document sources.
The Result tab consist two arrow buttons so the user can scroll through the reference library and a text field with the reference ID number so the user can go directly to the details of a certain reference.

<u>6.2.3 Basic functionality illustrated: Cobol and AS400</u>

A client wants to outsource the maintenance and management of several Cobol applications that mainly run on a IBM AS400 minicomputers. Therefore, a request for information is sent to potential outsource partners. In the response to this RFI some references have to be included that show the capabilities of managing and maintaining Cobol applications.
To select references the Sales employee fills in his search criteria in the Reference Tracking

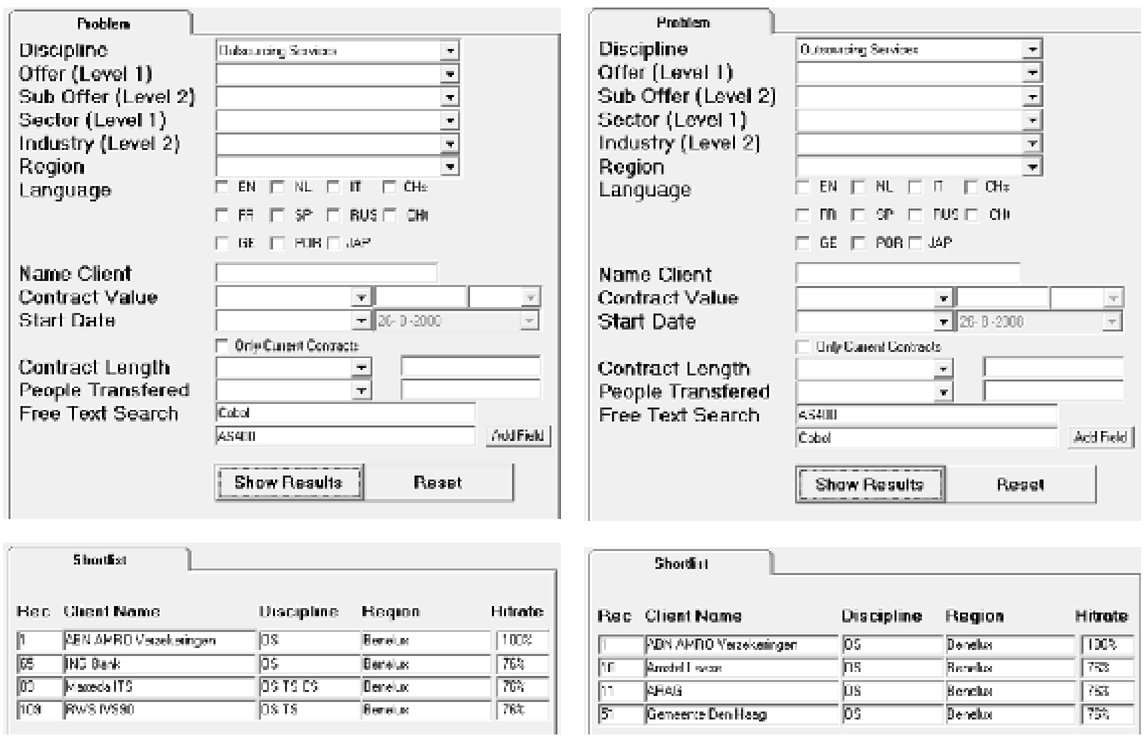


Figure 30: Search example for Cobol and AS400 references:
a) Search criteria Cobol and AS400; **b) Search criteria AS400 and Cobol;**
c) Hit rate Cobol and AS400; **d) Hit rate AS400 and Cobol**

System: Cobol and AS400. For the hit rate of the different references it depends whether Cobol or AS400 is defined as the major keyword. This is illustrated in Figure 30. Both reference shortlists present ABN AMRO Verzekeringen as the only reference that satisfies all search criteria. When Cobol is chosen as main keyword ING Bank, Maxeda and RWS are presented, but when AS400 is considered more important Amstel Lease, ARAG and Den Haag are returned as suitable references. Figure 30c shows the result of the search task shown in Figure 30a defining Cobol as main keyword. In Figure 30d – corresponding to the search task shown in Figure 30b - this is the other way around. Because the potential client wants to outsource Cobol application management, Cobol is the most important keyword. ING Bank, Maxeda and RWS are thus potential references, while Amstel Lease, ARAG and Den Haag are not.

It is clear that the search task shown in Figure 30a gives the most suitable reference shortlist. However, this example illustrates also that the impact of the Reference Tracking System largely depends on the user.

In Figure 31, both Cobol and AS400 can be found between the key technologies of ABN AMRO Verzekeringen.

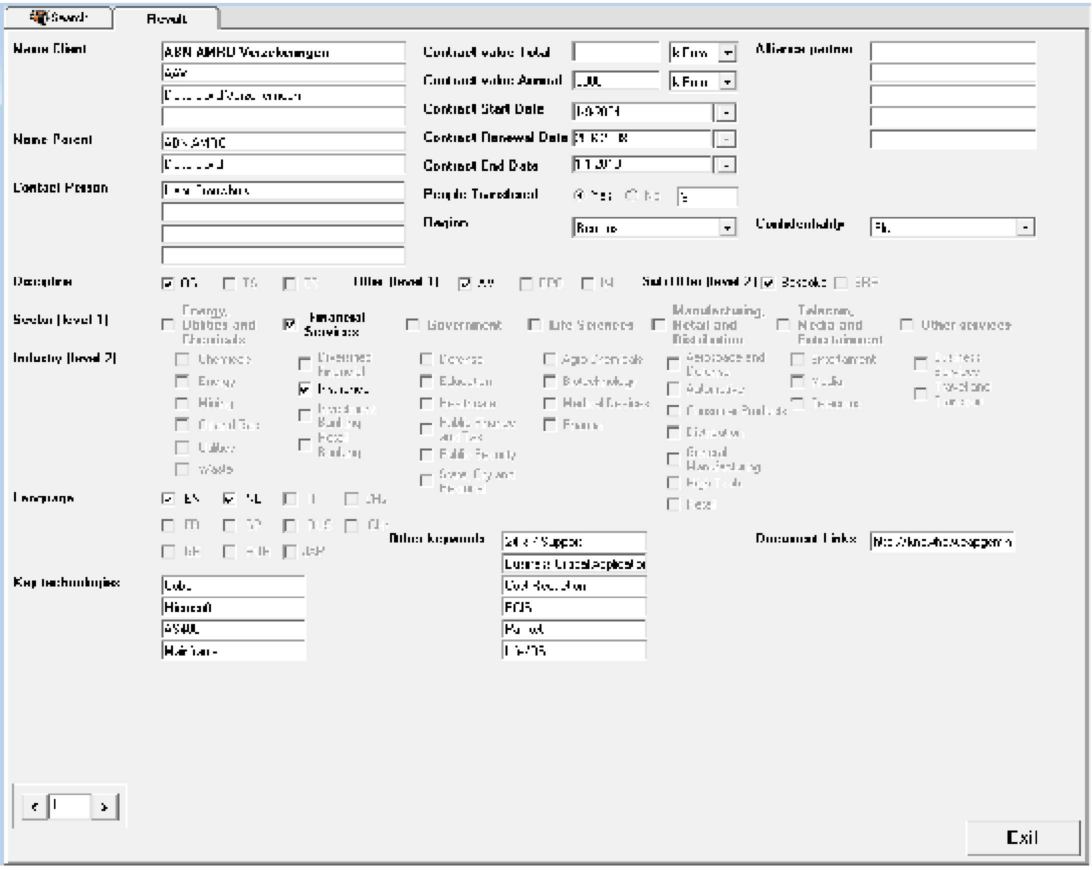


Figure 31: Overview of ABN AMRO Verzekeringen including Cobol and AS400

6.3 Level 1 application: advanced functionality

When a user clicks the advanced button on the button of the problem field of the Search tab (see Figure 27) and inserts his user name and password, the user gets advanced user rights. He has now the ability to add new references and to delete and modify old references he has included in the reference library in the past. This is done using the Result tab. This tab is the same as the basic user uses to get an overview of the details of a reference, but the advanced user has more rights. This is illustrated in Figure 32 that shows the same screen as Figure 29, but now with advanced user rights. Text fields, checkboxes and list boxes, that were previously grayed, are enabled and some new buttons have appeared. With this buttons the advanced user can delete the reference which details are shown and he can add a new reference. The arrows to scroll through the reference library are still available, but now there are also arrows to go directly to the first and the last reference in the library.

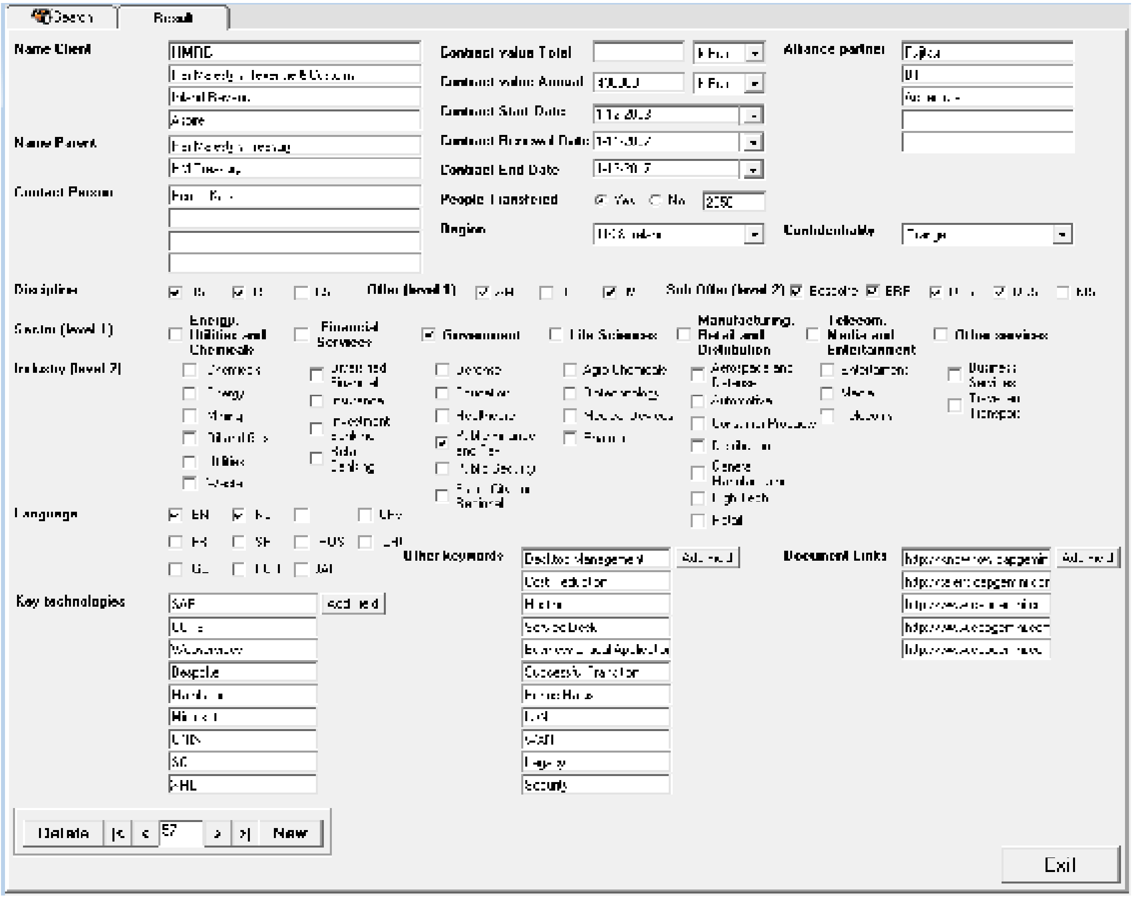


Figure 32: The Result tab of the Reference Tracking System with advanced user rights

6.3.1 Adding new references

By clicking on the New button, the user can add a new reference to the reference library. The user becomes automatically the owner of the new reference. He is the only one who can add details to the reference description or who can delete the referent.

Before adding a reference, the user has to gather some details regarding the reference, because a number of fields in the system are mandatory. The mandatory fields are colored red in Figure 33. These fields are obligatory to make sure that all references in the case library have a minimal description level and can be found using the search functionality of the Reference Tracking System.

The reference library of the Reference Tracking System does not include reference documents. The reference overview only contains links to the locations where the documents are stored (knowledge database). A link to a reference document is not obligatory, so a new referent can be added to the reference library, when details are known, but no reference document is yet created.

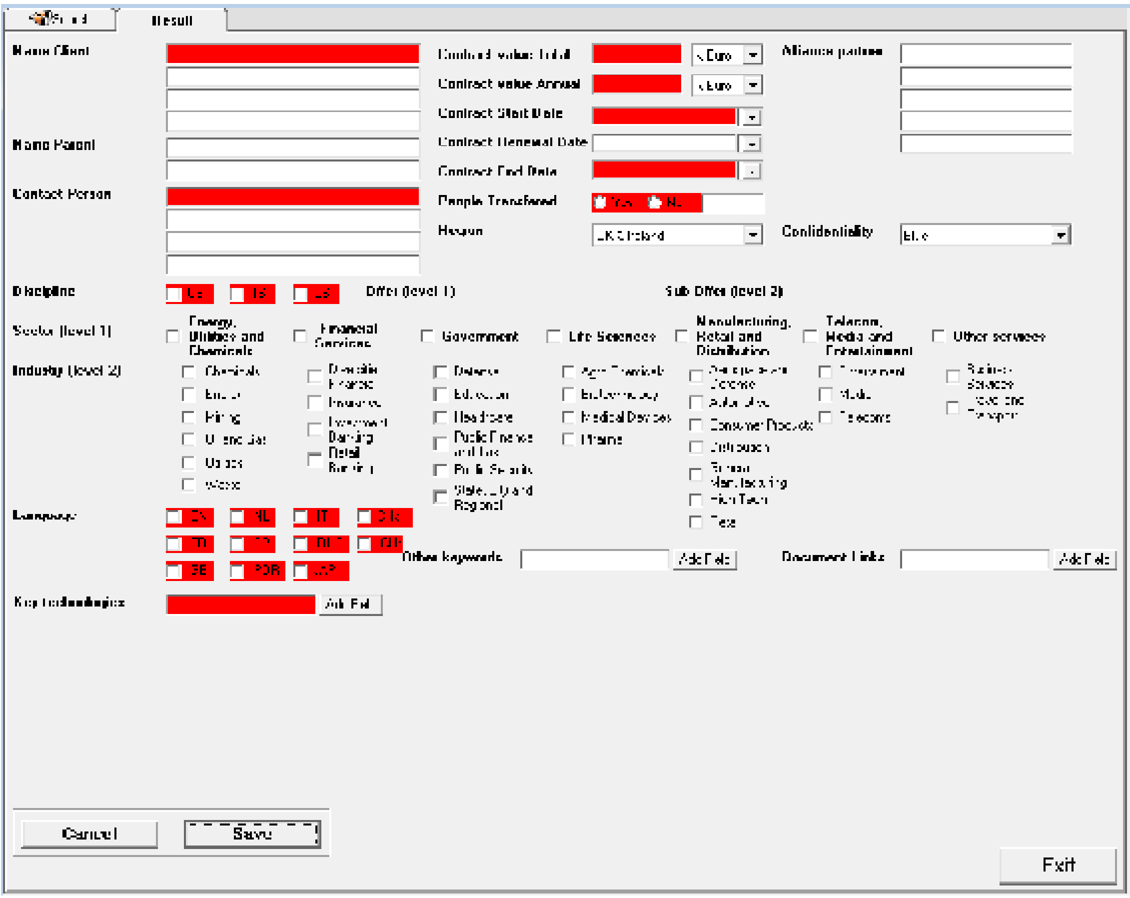


Figure 33: Mandatory fields when adding a reference

6.3.2 Deleting and modifying references

When logged in as advanced user, a user has the right to modify and delete reference descriptions. A modification is done by adding text in one of the text fields, modifying the content of one of the fields and ticking a checkbox. When the user scrolls through the reference library using the arrow buttons, the system automatically checked whether some of the content of the reference is changed. When changes are detected, the Reference Tracking System asks whether the changes should be saved. The modified cells are colored red. This is illustrated by Figure 34.

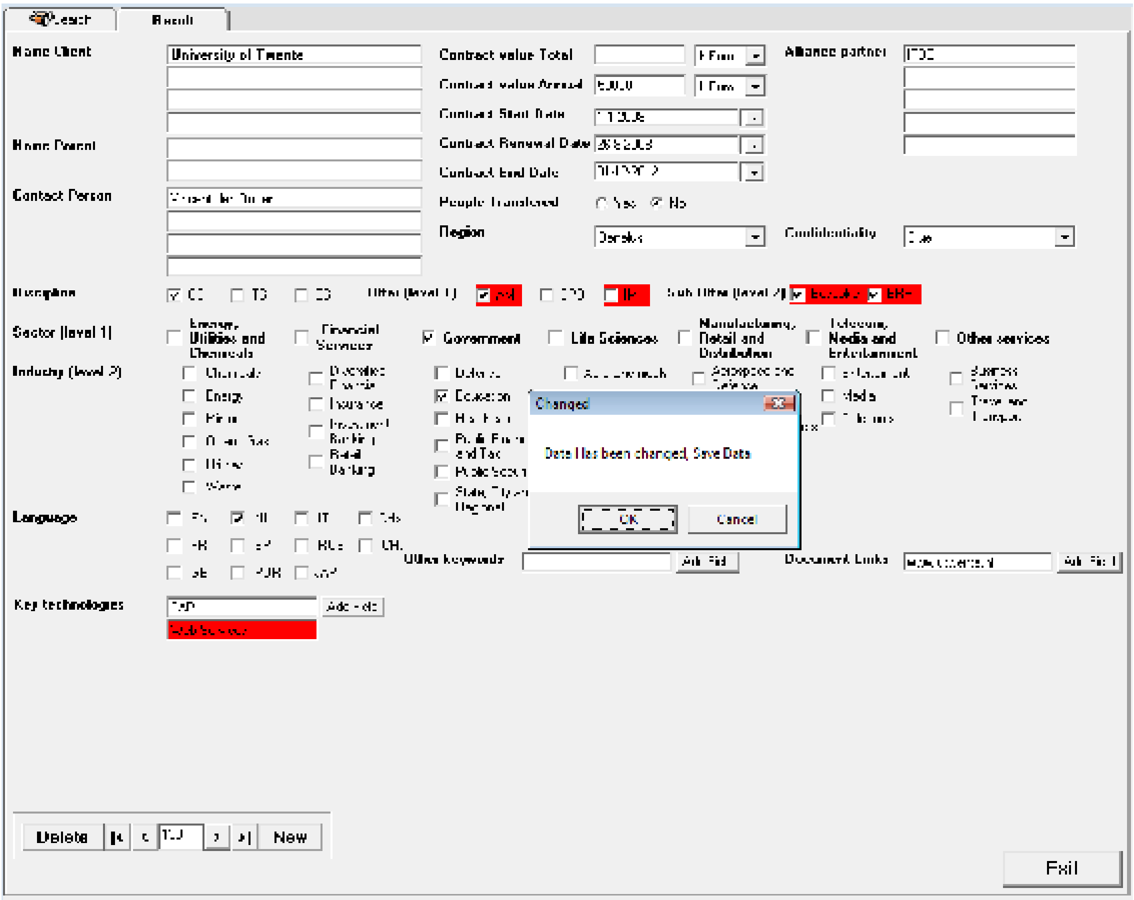


Figure 34: Modifying a reference in the Reference Tracking System

References are deleted using the Delete button.
However, a user can only alter and delete references he owns. When a modification is made in a reference owned by another user, the error message shown in Figure 35 is given by the system. When clicking OK, the system ignores the changes.

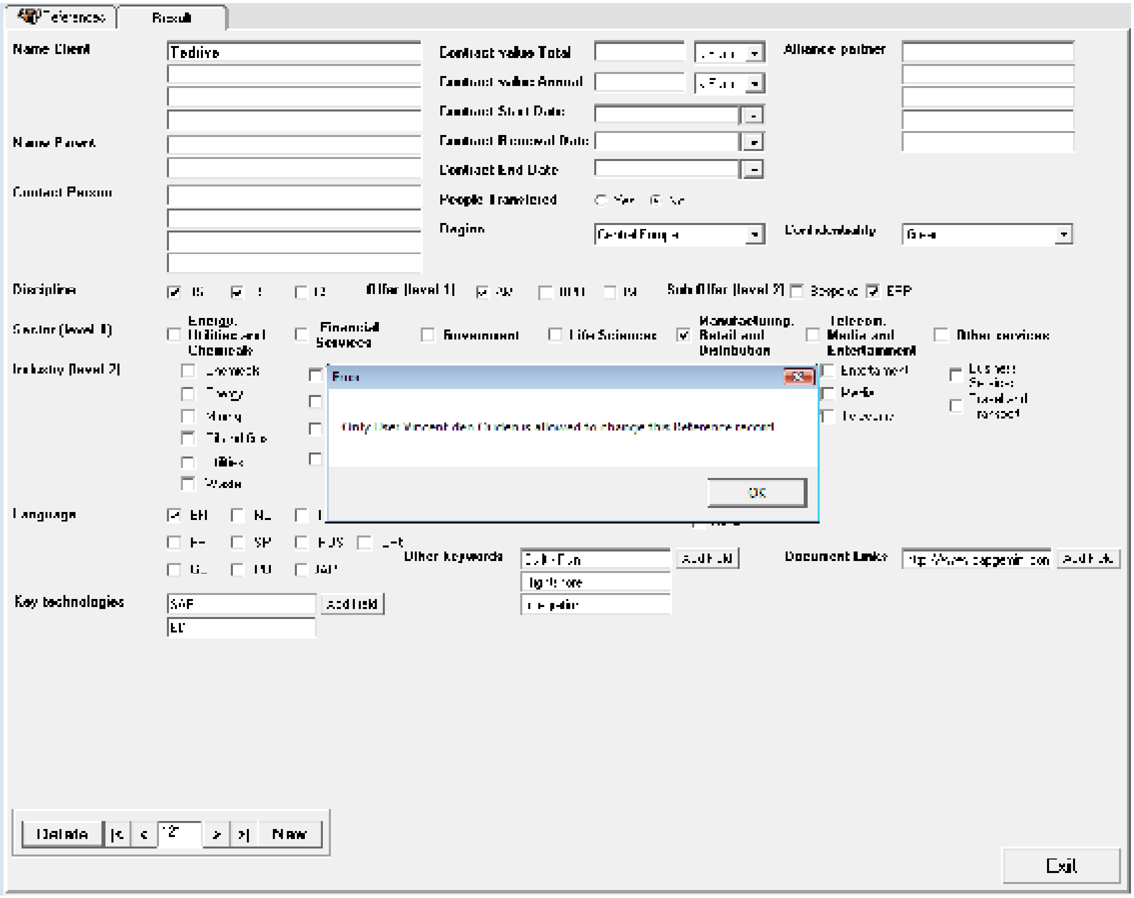


Figure 35: References protected against illegitimate deletion

7. Impact evaluation

During this graduation a prototype of the Reference Tracking System is created. Before this prototype can be used in practice, its impact should be analyzed. During this graduation an action research approach is used to evaluate the impact of the Reference Tracking System. In this chapter this evaluation is described.

7.1 Hypotheses & theoretical model

As discussed earlier, in the past the selection of references for bid trajectories was done ad hoc. There was no clear overview of the available references in the Netherlands, not to mention the references in the other regions of Capgemini. As a result, the selection of references depended mainly on the knowledge of sales employees and on the cooperation of personnel of other departments and regions of Capgemini.

The main goal of the Reference Tracking System is the improvement of the reference selection process within bid trajectories at the Sales department of Capgemini Outsourcing Netherlands. During this evaluation both the effectiveness and the efficiency of the reference selection process are measured using action research.

I expect that the Reference Tracking System would have a positive effect on both the effectiveness and the efficiency of the reference selection process at the Sales department of Capgemini Outsourcing Netherlands. During this evaluation two hypotheses will be tested using action research:

H1: The Reference Tracking System based on case-based reasoning improves the effectiveness of reference selection within bid processes at the Sales department of Capgemini Outsourcing Netherlands;

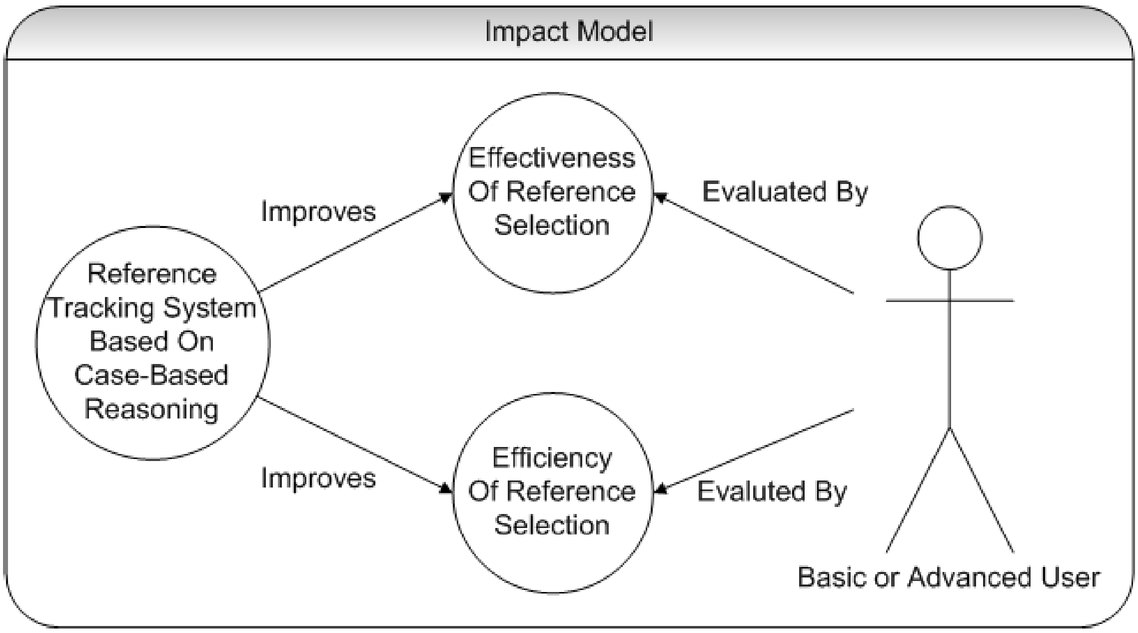


Figure 36: Impact model to test the impact of the artifact created using design science

H2: The Reference Tracking System based on case-based reasoning improves the efficiency of reference selection within bid processes at the Sales department of Capgemini Outsourcing Netherlands.

These two hypotheses and the measurement method used can be graphically shown using an impact model. This impact model is shown in Figure 36.

7.2 Action planning

The impact of the Reference Tracking System is evaluated using action research. This analysis is made up of two phases.
The first phase is an evaluation of the situation before the Reference Tracking System was used. This is called the pre-implementation measurement. This evaluation is done by performing and observing some reference selection processes in which the Reference Tracking System was not used. This is the null measurement.
The second phase is the post-implementation measurement. This measure evaluates the reference selection, while the Reference Tracking System is used by the sales employee.
The difference between these two situations is caused by the Reference Tracking System or in other words is the impact of the Reference Tracking System. This difference should support the hypotheses from Section 7.1.
As a side effect of the post-implementation measurement, the user can observe lacks in the system and indicate possible improvements. These suggestions can be used to refine the system. A part of these improvement suggestions is already implemented in the system. Other ideas are presented as technical recommendations.

7.3 Action taking

In this section the outcomes of the pre-implementation and the post-implementation measurements are described.

7.3.1. Pre-implementation measurement

During the different sessions with diverse employees of the Sales department of Capgemini Outsourcing Netherlands, the following picture of the situation at Capgemini before the implementation of the Reference Tracking System is sketched.
Until a few years ago, there was no overview of the services the different departments of Capgemini delivered to their customers. There was no single point of entry, so it was not easy to find appropriate references for bid processes. When a sales employee of Capgemini Outsourcing needed a reference about a certain topic, there were a lot of different locations where potentially appropriate references could be found. The knowledge was very shattered. Potential references and information about referents could be found:

- Within the memories of the sales employees. Most sales employees have knowledge about services delivered to diverse customers. A sales team could brainstorm about what references should be used in the response to a RFI, RFP or BAFO. The major limitation to this reference source is the knowledge of the sales employees. Most employees have only knowledge about the major referents, mainly originating from their own region. Minor contracts and contracts from other regions are less known, so they are hardly ever used.

- Within the diverse knowledge management systems of Capgemini. The old knowledge management system of Capgemini – Knew – contained a lot of knowledge. But due to the enormous amount of outdated information and the limited search functionality, this knowledge management system was hardly used. The substitute of this system – KM2.0 – has better search functionality, but when the content is not managed well, the risk exists that useful knowledge is swamped by obsolete knowledge. Furthermore, the Sales department of Capgemini Outsourcing Netherlands uses its own knowledge management system – Knowhow or Primus – with very advanced search functionality and limited content. A major disadvantage is that the user cannot search on reference details, because these systems contain not only reference documents, but all kinds of knowledge.
- At the different intranet sites of Capgemini – like Talent (international), Oxygen (Netherlands) and Ozone (Belgium) – and the external websites of the different regions of Capgemini. These sites contain success stories describing successful relationships with customers. Only very successful and large contracts are mentioned here, so this result also in a small list of references that are commonly used. Furthermore, it is very hard to select references based on detailed criteria, because the websites have only limited search functionality, because they are not meant to select references. At last, there are many different sites, so the reference supply is very shattered.
- Within the different delivery departments of Capgemini Outsourcing (Application Management, Infrastructure Management, Retail Solutions). When specific infrastructure management or applications management references from the Netherlands are needed, it is easy for a sales employee to ask employees of the different offers whether they know suitable references. However, just like reference supply on the websites, the knowledge about references is spread all over the service lines. Moreover, references from other regions are hard to find this way.

All locations have the disadvantage that particularly large contracts are known and traceable. Minor contracts are hard to find, although they may be suitable. Reference selection results often in the same referents. And it is very hard to select references based on certain keywords and contract details. To a large extent, the selection result depends on the knowledge and the network of the person that is looking for suitable references.

It is clear that the reference resources are very shattered. Often, a sales employee has to search in fifteen to twenty locations to find suitable references for a response to a request. Therefore, it took a lot of time and effort for collecting suitable references to include in responses to requests. The large international references are traceable, but small ones are nearly invisible for employees from other regions, not to mention that they can select a small reference based on some search criteria.

Finding suitable references sometimes costs more than two weeks, but this is not only the result of the fragmented reference supply. It costs also a lot of time and effort to contact the service manager responsible for the contract and to acquire necessary information regarding a contract. These are especially issues when contracts from other regions are used within the response to a request and the questions asked are not very common.

Since the introduction of Primus – a knowledge management system – in the Sales department of Capgemini Outsourcing Netherlands the reference supply has been improved and has become more centralized. As a result the sales employees within Capgemini Outsourcing Netherlands have a better overview of the available references. However, further improvements and more advanced search and selection functionality is desired and recommended, especially because knowledge from other regions is still hard to find.

7.3.2. Post-implementation measurement

When a first version of the prototype of the Reference Tracking System was finished, some users – both basic and advanced users – were asked to use the system within reference selection processes. First, they got an explanation about the functionality of the system. Thereafter, they used the system by themselves.

Overall, the users' reactions were positive but critical. The Reference Tracking System was quite easy to use, although not all search topics were clear at first sight. But when the users perform more and more search tasks, the functioning of the Reference Tracking System became clearer. No or minimal training is needed to use the system, so the usability performance requirement is satisfied (see Table 8).

First of all, the users were glad that the system provides a single point of access to all knowledge sources that contain reference documents. No longer the user has to search for references in multiple knowledge management systems and has to visit numerous websites. The advantage of a single point of entry is limited due to the fact that at this moment the system only contains a limited number of references from regions other than the Benelux. As is shown in Table 6 in Section 6.1, only 25 of the 137 references originates from other regions. And the majority of these foreign references are major contracts with an annual contract value of more than 5 million Euros that were already well traceable in the past. The performance and usefulness of the Reference Tracking System largely depends on the other regions that have to insert their customer details. As one user stated: '*the set-up has improved a lot, but we still draw from the same sources. If other countries give their input, this will make an enormous difference for the performance of the system.*' The nonfunctional requirement that the system should contain as much references as possible from all regions of Capgemini is not yet satisfied. This needs further improvement and effort. The system provides a single point of access to all references in the Netherlands, but not all references worldwide (see Table 8).

The second remark the users made was regarding the possibility to search for references that use a certain technology or was marked with a certain keyword. In the past it was hard to search for references that involve the management of for example AS400 servers, Cobol applications or hosting activities. Now the user can insert some keywords and suitable references are returned. The major barrier to find appropriate references is the lack of a keyword selection mechanism like a keyword list or a topic tree. A user has to try several possible keywords before the right one is inserted. And when a certain keyword is not included in the system library, the user wastes time and effort instead of saving it. For example, during one of the sessions the user was searching for a reference that included file and print functionality. Because file and print is a common element of desktop management and office automation, it is not included as a separate keyword, so the user found no references matching the search criteria. It is clear that this lack of a keyword guide is a very important and urgent improvement point that decreases the ease of use and usefulness of the system. The lack of a mechanism for keyword selection is also a problem when storing new references in the reference library in a way that they can be found using the search functionality of the reference selection system. It is clear that the Reference Tracking System satisfies three of the four functional requirements; it does not yet contain a means to manage keywords, but it provides an indexing mechanism, hit rate and presentation list, it is possible to search for references that comprise more than the requested service and it contains a means to enter new references (see Table 8).

Contacting the service manager responsible for the contract and the acquisition of necessary information regarding a contract are also two issues that can take a lot of time and effort. These problems are not tackled by the Reference Tracking System. But when the content of the reference library is maintained well, the system can also reduce these issues. Searching for the right contact person of a reference can be prevented, when a new service manager is inserted in the system. When enough facts regarding a contract are inserted in the reference library, the number of requests for more details can be reduced. To guarantee reliable and complete content in the reference library the processes to update the content should be organized well and the responsibilities and reference ownerships should be clear. The adequacy of knowledge performance requirement is thus not yet satisfied (see Table 8).

7.4. Impact of the system

The system delivers some important improvements to the reference selection process. It solves some of the common problems of case-based reasoning that also apply to reference selection. In this section is discussed how well the Reference Tracking System satisfies the requirements discussed in Section 4.4.

In Table 8 is summarized which requirements are satisfied by the Reference Tracking System. Some of these requirements are already explained in the previous paragraph. The other requirements are explained in this section.

The impact of the prototype of the Reference Tracking System is only measured within the Netherlands. During the design knowledge managers from other regions are involved, but there is no proof that the system is supported by users from all regions of Capgemini.

The system contains security measures, although they need further improvement. Because the Reference Tracking System contains links to documents and no documents, the system is independent of reference document format and location. All keywords are in English. When a keyword management mechanism is implemented, this mechanism should only contain English keywords.

The prototype of the Reference Tracking System is a stand alone system, although it is quite easily connected to other systems. Furthermore, the system is already linked to the diverse knowledge management systems of Capgemini via the document links in the reference descriptions.
The prototype of the Reference Tracking System returns the hit rates quite soon, but at this moment it is unclear if the final system will also be efficient in calculating hit rates and presenting the reference shortlist. Especially when the reference library contains more than thousand references, the calculation of the hit rates could take too much time.

Requirement	**Satisfied?**
The system should provide a mechanism that indexes the match between the different references and the requirements (hit rate) and present the best matching references (f)	Yes
The system should provide a way to select references that comprise more than the requested service (f)	Yes
The system should contain a means to enter new references (f)	Yes
The system should contain a means to manage the keywords used (f)	No
The system should be supported by the users worldwide (nf)	?
The system should contain as much references as possible from all over the world (nf)	No
The system should provide a single point of access to all references in the Netherlands (nf)	Yes
The system should provide a single point of access to all references worldwide (nf)	No
The system should contain some security measures (nf)	Yes
The system should be independent of reference document format (nf)	Yes
The system should be independent of reference document location (nf)	Yes
The system should be in one single language (nf)	Yes
Effectiveness of the system (p)	Yes
Adequacy of knowledge (p)	No
Practicability or usability (p)	Yes
Efficiency (p)	?
Reliability of the system (p)	?
Maintainability (p)	?
Portability (p)	?

Table 8: Satisfaction of requirements
(f: functional requirement, nf: nonfunctional requirement, p: performance requirement, yes: requirement is satisfied, no: requirements is not (yet) satisfied, ?: no proof that requirement is satisfied)

During this graduation study the system was almost always available, so it has a high reliability. By releasing new versions of the system, the Reference Tracking System does not need maintenance shutdowns. The system is built to ensure limited maintenance, but at this moment it is unclear if the system will be easy to maintain. During this graduation research study, the Reference Tracking System is tested on both Windows XP and Windows Vista machines. The migration from one system to the other sometimes goes well, but it also happens that some supporting files were missing which resulted in a nonfunctioning system.

The determining factor that can make or break the impact of the system is the support of other regions. When other regions refuse to insert the details of their contracts in the reference library, the system mainly contains references from the Netherlands. These references could also be found in the old situation before the implementation of the Reference Tracking System. In that case, only the search possibilities are improved. To really grasp the full benefits from the system, input and support from other regions is necessary.
And even then the system does not solve all issues. The gathering of specific details regarding contracts will still take time and effort, but if the system is maintained well the name of the right contact person is always available and communication could be simplified.
It can be concluded that the Reference Tracking System improves the efficiency of reference selection. This improvement can be increased when a keyword guide is included in the reference selection system. The system also improves the effectiveness of the reference selection process by providing a single point of entry, although the lack of references from other regions reduces this improvement. Both hypothesis H1 and hypothesis H2 are supported, but both improvements can be increased by further refining the Reference Tracking System and increasing the content of the reference library.

7.5. Refinements of Reference Tracking System

During the different sessions with users some potential refinements of the system were mentioned. The list of keywords – originally based on a keyword list from the United Kingdom – is extended with suggestions from sales employees from the Netherlands and knowledge managers from other regions. The keyword list is a dynamic list that needs to be updated on a regular basis. The current keyword list is in Appendix C.
Another user refinement that is carried out is the distinction between the ERP branch and the bespoke branch in the application management service line. By adding this refinement a user can divide application management references in references that include the management of software packages and references that deal with the management of custom-made applications. This is a common distinction in the application management department.
Next to these refinements the users made some suggestions that are not included in the prototype due to time constraints.
The major refinement of the reference selection system is the addition of a keyword guide to help advanced users describing the reference they are adding to the reference library and facilitating the search task basic users execute. As discussed in Section 5.3 combo boxes or

topic trees containing the possible keywords should be used in the final Reference Tracking System as a keyword guide.
A reference description in the reference library of the reference selection system includes the annual and total contract value of the contract. These contract values can be expressed in several currencies: Euros, Dollars and Pounds. The user has to fill in at least one of the contract values. The system provides the possibility to search for references with a certain contract value. When the currency of the contract value filled in is Dollars or Pounds, but the user searches for a contract worth a certain amount of Euros, the system does not calculate the contract value in Euros. The same counts when a user searches for contracts with a certain annual contract value. When only a total contract value is filled in, the annual contract value is not calculated. The implementation of a contract value calculator was also a user suggestion.

Conclusions

This graduation assignment was the result of a practical problem within the Sales department of Capgemini Outsourcing. At the last global knowledge management meeting several spearheads are determined among which reference selection. References are a common part of customer's requests. The customer asks for several references that show Capgemini's capabilities on a certain area. In the past, searching and selecting references that satisfy these demands was done ad hoc. No fixed routine was available and the result depended on the sales employee involved. Reference selection costs a lot of time and effort from sales employees and frequently no appropriate references could be found what resulted in lost bid trajectories.
This practical problem resulted in the following research question that is answered during this graduation study:

How can case-based reasoning improve knowledge selection in reference search?

The answer to this practical problem is in the practical conclusions. The scientific conclusions take these conclusions to a higher level, taking a broader view on case-based reasoning in knowledge selection. This chapter ends with the limitations of this graduation research study.

Practice

During this graduation research study a reference selection system based on case-based reasoning is designed, developed and a prototype of this Reference Tracking System is built.
The implementation of the Reference Tracking System within the Sales department of Capgemini Outsourcing Netherlands had improved the reference selection process.
First of all, the system provides a single point of entry to sales employees that gives access to reference documents at diverse locations, like knowledge repositories and web pages, on condition that these locations are linked to a reference description in the reference library.
Secondly, the system provides search functionality specially designed to find suitable references for bid trajectories, while the internet and intranet sites where success stories are published contain no search functionality and the knowledge repositories of Capgemini contain common search functionality, because they contain not only reference documents but also building blocks, presentations and other documents. This advanced search functionality results in a reference selection that is based on the real match of the references with the customer's requirements instead of the match perceived by the sales employees involved in reference selection. This increases the overall appropriateness of the selected references. Moreover, also references that include more areas than only the topic searched for can be found using the Reference Tracking System, increasing the quality of the chosen reference even more. The advantage of this advanced search functionality is limited by the lack of a keyword guide that causes useless search tasks, because keywords are not used within the

reference descriptions in the reference library. This is one of the major system refinements that should be included in the final system.
Furthermore, when references from all regions are inserted in the reference library, the system increases the span of the reference search. At this moment mainly references from the Benelux are used in Dutch bid trajectories. When the customer has special requirements, like a certain contract value or rare technologies references from other regions are needed, but hard to find. The Reference Tracking System has the potential to make selecting foreign references more easy.
At last, the reference selection system facilitates not only reference selection, but it guides advanced users, who have a new reference. In the past, several standard documents were available in which references can be stored. The Reference Tracking System provides a means for storing references in a way that other users can easily select this reference for reuse. To improve this functionality a keyword guide is also desired.
Overall, the Reference Tracking System improves the reference selection process within the Sales department of Capgemini Outsourcing Netherlands. When some technical refinements to the system are made and the reference library is supplemented with references from other regions and disciplines of Capgemini, this impact is even enlarged.
It is clear that case-based reasoning can improve knowledge selection in a reference search. As stated in Section 2.2 case-based reasoning is used extensively in day-to-day common sense. The sales employees of Capgemini use case-based reasoning to select references for bid processes. In essence, the Reference Tracking System does not introduce a new way of selecting references, but it supports the sales employee in case-based reasoning. Case-based reasoning can thus improve the knowledge selection in a reference search by facilitating the case-based reasoner (the sales employee).

Science

During this graduation research study it is proven that a system based on case-based reasoning can improve the knowledge selection process. When a person selects knowledge ad hoc – without the use of a system – he usually uses case-based reasoning without knowing it. The fact is that case-based reasoning is used extensively in day-to-day common sense. This simplifies the implementation of a knowledge selection system founded on case-based reasoning, because there is no need for major process changes.
Reference selection within the Sales department of Capgemini Outsourcing is a knowledge selection process in which pieces of knowledge can be clearly defined (the references deal with clearly demarcated services) and described (by using for example involved departments, key technologies and other keywords) and there are clear selection criteria (the customer demands). A knowledge selection process with these characteristics can be easily facilitated by an intelligent system.
Because a limited number of personnel is involved in reference selection (the Sales employees) the user population of the Reference Tracking System can be clearly defined. In many other situations, a more extended and more diverse user population is involved in knowledge selection. This complicates the introduction and implementation of a knowledge

selection system founded on case-based reasoning. However, the diversity of the user population is a common issue dealt with in many information system implementations, so this would not obstruct the success of a knowledge selection system based on case-based reasoning.

It can be concluded that case-based reasoning can be used in diverse knowledge selection situations. Case-based reasoning is a common way of reasoning, often used without the user knowing he is a case-based reasoner. Because of the characteristics of case-based reasoning, it should be useful in supporting knowledge selection in various, diverse situations, although the implementation would be more difficult in more complex situations.

Limitations

This research has some major limitations that are already mentioned briefly in the previous section. These limitations make it hard to generalize the practical conclusions to other situations than the situation at the Sales department of Capgemini, although this generalization is done in the previous section.

First of all, the reference selection process has some specific characteristics. First, a reference can be clearly demarcated, while this can be a problem with other knowledge items. In the second place, all pieces of knowledge in the reference selection process are similar. All references can be described using the same concepts. It can be hard to find a way to describe more diverse pieces of knowledge unambiguous. At last, the selection criteria in reference selection can be clearly defined. In more fuzzy knowledge selection processes it can be hard to create a clear description of the needed knowledge. Reference selection is a clear case of multiple attribute decision making. This research study provides little leads that case-based reasoning is also suitable for knowledge selection in more fuzzy cases in which the requirements and characteristics of the alternatives are less clearly described – knowledge selection that is more like multiple objective decision making.

Furthermore, reference selection within Capgemini Outsourcing Netherlands was a process that takes place within a clearly defined setting. This situation simplifies the research done, because there is a quite stable group of stakeholders who focus entirely on responding to requests. The effects of this specialization on the impact of the Reference Tracking System limit the generalizability of this research.

Recommendations

Just like the conclusions, the recommendations can be divided into practical recommendations and scientific recommendations. The practical recommendations can be divided into organizational recommendations and technical recommendations. The scientific recommendations consist of some suggestions for future research.

Practice

The practical recommendations can be divided into organizational recommendations about how the organization can improve the use of the Reference Tracking System and technical recommendations about how the functionality of the Reference Tracking System can be improved.

Organizational

In this paragraph, I present some organizational recommendations for Capgemini to make the Reference Tracking System a success.
Factors influencing the success of implementations of information systems are a popular research topic among scientists. Research has been performed to the implementation of diverse types of information systems in all types of organizations (for example Akkermans & Van Helden, 2002; Berg, 2001; Davis et al, 1989; Somers & Nelson, 2001; Venkatesh & Davis, 1996; 2000; Venkatesh et al, 2003; Wixom & Watson, 2001). The most important factors for a successful implementation of an information system that appeared during these studies are user support, management support and the availability of resources. Another important factor that influences the success of the Reference Tracking System is interdepartmental cooperation.
The importance of user support is mentioned several times in this graduation report. The system can only be a complete success if all regions of Capgemini gave their input to the reference library. To do this they need to notice the importance and usefulness of the system. During the design and development of the system knowledge managers from other regions are involved in the design of the system. At this moment, the first prototype of the Reference Tracking System is finished, but their input remains important, especially because references from other regions need to be inserted in the reference library. The support from other regions can be increased by setting up a steering committee consisting of the knowledge managers and some key users from different regions.
The second important factor influencing the success of the Reference Tracking System is support from senior management. Top management should exhibit commitment to the successful introduction of the reference selection system, lay down responsibilities and communicate the introduction of the Reference Tracking System to all users when it is finished. Moreover, management should encourage the use of the system. A way to show management support is by appointing a champion, for example the global knowledge management leader of Capgemini.

The third success factor is the availability of financial, human and other resources to create a well functioning system that includes all references from all regions. Some resources will remain necessary to keep the reference library up-to-date, although this will request limited resources compared to the initial need of resources to insert all references that are currently available.

At last, interdepartmental cooperation is important. During the evaluation sessions with diverse employees of the sales department of Capgemini Outsourcing Netherlands another factor that costs a lot of time and effort appeared. When a suitable referent is found, the available reference documents should be adjusted to the customer's demands. For this purpose it is necessary that the service manager – member of one of the delivery departments – responsible for the contract reviews the reference and gives feedback. By making the writing of reference documents and supporting bid processes one of the key performance indicators of the service managers, their support could be increased. This limits the time and effort needed for creating a good reference document as part of the response to a customer's service request.

<u>Technical</u>

In this paragraph, I present some recommendations about how to improve the Reference Tracking System to make sure it can provide an optimal support to the Sales employees of Capgemini.

In the prototype there is no measure included that takes care of the uniformity of the keywords. To prevent the use of different synonyms and abbreviations for one concept, it is important that such measure is included in the final system. In Section 5.3, some possible countermeasures to target this problem are mentioned. I recommend replacing all text fields in the Reference Tracking System by combo boxes or topic trees forcing the use of the same keywords in each search task or reference description.

The second refinement of the Reference Tracking System is the inclusion of a calculator module that converts the annual contract value into the total contract value and visa versa using the contract length and that converts the different currencies into each other using the exchange rate. This module should be activated when a user searches for references with a certain annual or total contract value.

Furthermore, the reference database that is currently in a simple comma separated text file should be placed in a relational database such as a MS SQL database, an Access database or a XML database. At last, the user management module is not yet created. This module should be created, so new advanced users can be created and obsolete advanced users can be deleted. In the prototype only the creator (the owner) of a reference can alter or delete this reference. This can be changed so all advanced users from a certain region can modify and remove references from that region.

Further research

These suggestions for further research are a logical consequence of the limitations of this graduation research study discussed in the last section of the previous chapter. As described in that section the main limitations of this research were the specific characteristics of the reference selection process and the situation in which the reference selection process takes place. Future research should mainly address these topics.

Future research should focus on the design and the impact of intelligent knowledge selection systems founded on case-based reasoning in knowledge selection processes with diverse characteristics and used in diverse situations.

During this research study it is proven that an intelligent system based on case-based reasoning improves knowledge selection in cases where the knowledge is clearly defined and described and there are unambiguous selection criteria. However, this proof is limited because only one organization was involved in the research. This proof should be extended with research in more organizations, operating in diverse industry sectors.

Furthermore, scientists should study the impact of a knowledge selection system based on case-based reasoning in cases, where the pieces of knowledge are demarcated less clearly and described less unambiguously and where the selection criteria are fuzzier and less easy to determine.

The last suggestion for further research deals with the method improving knowledge selection. In this research case-based reasoning is used to improve the knowledge selection process. Scientists should study the impact of other methodologies on the efficiency and effectiveness of knowledge selection.

These research topics will result in a complete view about the factors influencing the effectiveness and efficiency of the knowledge selection process, a field currently barely researched.

References

Acorn, T. & Walden, S. (1992). SMART: support management automated reasoning technology for Compaq customer service. *Proceedings of the fourth Innovative Applications of Artificial Intelligence Conference.*

Aha, D.W. (1998). The omnipresence of case-based reasoning in science and application. *Knowledge-Based Systems, Vol. 11,* No. 5-6, pp. 261-273.

Aizawa, A. (2003). An information-theoretic perspective of TF–IDF measures. *Information Processing and Management, Vol. 39,* No. 1, pp. 45-65.

Akkermans, H. & Van Helden, K. (2002). Vicious and virtuous cycles in ERP implementation: a case study of interrelations between critical success factors. *European Journal of Information Systems, Vol. 11,* No. 1, pp. 35-46.

Alavi, M. (1997). KPMG Peat Marwick U.S.: one giant brain. *Harvard Business School (Case).*

Alavi, M. & Leidner, D.E. (1999). Knowledge management systems: issues, challenges, and benefits. *Communications of the Association for Information Systems, Vol.* 1, article 7.

Alavi, M. & Leidner, D.E. (2001). Review: knowledge management and knowledge management systems: conceptual foundations and research issues. *MIS Quarterly, Vol. 25,* No. 1, pp. 107-136.

Allen, B.P. (1994). Case-based reasoning: business applications. *Communications of the Association for Computing Machinery, Vol. 37,* No. 3, pp. 40-42.

Anand, V., Manz, C.C. & Glick, W.H. (1998). An organizational memory approach to information management. *Academy of Management Review, Vol. 23,* No. 4, pp. 796–809.

Arthur Andersen and the American Productivity and Quality Center (1996). *The knowledge management assessment tool: external benchmarking version.*

Avison, D.E., Lau, F., Myers, M.D. & Nielsen, P.A. (1999). Action research. *Communications of the Association for Computing Machinery, Vol. 42,* No. 1, pp. 94-97.

Baskerville, R. (1999). Investigating information systems with action research. *Communications of the Association for Information Systems, Vol. 2,* Article 19.

Berg, M. (2001). Implementing information systems in health care organizations: myths and challenges. *International Journal of Medical Informatics, Vol. 64,* No. 2-3, pp. 143-156.

Bhagat, R.S., Kedia, B.L., Harveston, P.D. & Triandis, H.C. (2002). Cultural variations in the cross-border transfer of organizational knowledge: An integrative framework. *Academy of Management Review, Vol. 27,* No. 2, pp. 204-221.

Bloodgood, J.M. & Salisbury, W.D. (2001). Understanding the influence of organizational change strategies on information technology and knowledge management strategies. *Decision Support Systems, Vol. 31,* No. 1, pp. 55-69.

Choudhury, V. & Sampler, J.L. (1997). Information specificity and environmental scanning: an economic perspective. *MIS Quarterly, Vol. 21,* No. 1, pp. 25-53.

Cook, S.D.N. & Brown, J.S. (1999). Bridging epistemologies: the generative dance between organizational knowledge and organizational knowing. *Organization Science, Vol. 10,* No. 4, pp. 381-400.

Datta, A. & Thomas, H. (1999). The cube data model: a conceptual model and algebra for on-line analytical processing in data warehouses. *Decision Support Systems, Vol. 27*, No. 3, pp. 289-301.

Davenport, T.H., De Long, D.W. & Beers, M.C. (1998). Successful knowledge management projects. *Sloan Management Review, Vol. 39*, No. 2, pp. 43-57.

Davis, F.D., Bagozzi, R.P. & Warshaw, P.R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management Science, Vol. 35*, No. 8, pp. 982-1003.

Dyer, J.H. & Nobeoka, K. (2000). Creating and managing a high-performance knowledge-sharing network: the Toyota case. *Strategic Management Journal, Vol. 21*, No. 3, pp. 345-367.

Farbey, B., Land, F.F. & Targett, D. (1995). A taxonomy of information-systems applications – the benefits of evaluation ladder. *European Journal of Information Systems, Vol. 4*, No. 1, pp. 41-50.

Grant, R.M. (1996a). Toward a knowledge-based theory of the firm. *Strategic Management Journal, Vol. 17*, Special Issue: Knowledge and the Firm, pp. 109-122.

Grant, R.M. (1996b). Prospering in dynamically-competitive environments: organizational capability as knowledge integration. *Organization Science, Vol. 7*, No. 4, pp. 375-387.

Grover, V. & Davenport, T.H. (2001). General perspectives on knowledge management: fostering a research agenda. *Journal of Management Information Systems, Vol. 18*, No. 1, pp. 5-21.

Gruber, T.R. (1993). A translation approach to portable ontology specifications. *Knowledge Acquisition, Vol. 5*, No. 2, pp. 199-220.

Guo, M.-Z. & Li, J.-F. (2006). Improving retrieval performance with the combination of thesauri and automatic relevance feedback. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), Vol. 3930 LNAI*, pp. 322-328.

Hansen, M.T. (1999). The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. *Administrative Science Quarterly, Vol. 44*, No. 1, pp. 82-111.

Hansen, M.T. (2002). Knowledge networks: explaining effective knowledge sharing in multiunit companies. *Organization Science, Vol. 13*, No. 3, pp. 232-248.

Hansen, M.T., Nohria, N. & Tierney, T. (1999). What's your strategy for managing knowledge? *Harvard Business Review, Vol. 77*, No. 2, pp. 106-116.

Heib, R., Daneva, M. & Scheer, A.-W. (1996). ARIS-based reference model for benchmarking. *Institut für Wirtschaftsinformatik, Vol. 131*.

Hevner, A.R., March, S.T., Park, J. & Ram, S. (2004). Design science in information systems research. *MIS Quarterly, Vol. 28*, No. 1, pp. 75-105.

Holsapple, C.W. & Joshi, K.D. (1999). Description and analysis of existing knowledge management frameworks. *Proceedings of the 32nd Annual Hawaii International Conference on System Sciences, Vol. Track 1*.

Holsapple, C.W. & Joshi, K.D. (2000). An investigation of factors that influence the management of knowledge in organizations. *Journal of Strategic Information Systems, Vol. 9*, No. 2-3, pp. 235-261.

Holsapple, C.W. & Joshi, K.D. (2002a). Knowledge management: a threefold framework. *The Information Society, Vol. 18*, No. 1, pp. 47–64.

Holsapple, C.W. & Joshi, K.D. (2002b). Knowledge manipulation activities: results of a Delphi study. *Information & Management, Vol. 39*, No. 6, pp. 477-490. (Cited: 33)

Holt, G.D., Olomolaiye, P.O. & Harris, F.C. (1994). Applying multi-attribute analysis to contractor selection decisions. *European Journal of Purchasing & Supply Management, Vol. 1*, No. 3, pp. 139-148.

Inkpen, A.C. & Dinur, A. (1998). Knowledge management processes and international joint ventures. *Organization Science*, *Vol. 9*, No. 4, pp. 454-468.

Kanitkar, V. & Delis, A. (2002). Real-time processing in client-server databases. *IEEE Transactions on Computers, Vol. 51*, No. 3, pp. 269-288.

Kolodner, J.L. (1992). An introduction to case-based reasoning. *Artificial Intelligence Journal, Vol. 6*, No. 1, pp. 3-34.

Kolodner, J.L. & Kolodner, R.M. (1987). Using experience in clinical problem solving. *IEEE Transactions on Systems, Man and Cybernetics, Vol. 17*, No. 3, pp. 420-431.

Lee, J.N. (2001). The impact of knowledge sharing, organizational capability and partnership quality on IS outsourcing success. *Information & Management, Vol. 38*, No. 5, pp. 323-335.

March, S.T. & Smith, G.F. (1995). Design and natural science research on information technology. *Decision Support Systems, Vol. 15*, No. 4, pp. 251-266.

Markus, M.L. (2001). Toward a theory of knowledge reuse: types of knowledge reuse situations and factors in reuse success. *Journal of Management Information Systems, Vol. 18*, No. 1, pp. 57–93.

McLure Wasko, M. & Faraj, S. (2000). ”It is what one does”: why people participate and help others in electronic communities of practice. *Journal of Strategic Information Systems, Vol. 9*, No. 2-3, pp. 155-173.

McLure Wasko, M. & Faraj, S. (2005). Why should I share? Examining social capital and knowledge contribution in electronic networks of practice. *MIS Quarterly, Vol. 29*, No. 1, pp. 35-57.

Moody, D.L. & Shanks, G.G. (2003). Improving the quality of data models: empirical validation of a quality management framework. *Information Systems, Vol. 28*, pp. 619-650.

Nonaka, I. (1991). The knowledge creating company. *Harvard Business Review, Vol. 69*, No. 6, pp. 96-104.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, Vol. 5*, No. 1, pp. 14-37.

Nonaka, I. & Takeuchi, H. (1995). *The knowledge-creating company: how Japanese companies create the dynamics of innovation.* Oxford University Press, New York.

Nonaka, I., Toyama, R. & Konno, N. (2000). SECI, Ba and leadership: a unified model of dynamic knowledge creation. *Long Range Planning, Vol. 33*, No. 1, pp. 5-34.

Orlikowski, W.J. & Iacono, C.S. (2001). Research commentary: desperately seeking the "IT" in IT research - a call to theorizing the IT artifact. *Information Systems Research, Vol. 12*, No. 2, pp. 121-134.

Pisano, G.P. (1994). Knowledge, integration, and the locus of learning: an empirical analysis of process development. *Strategic Management Journal, Vol. 15*, Special Issue: Competitive Organizational Behavior, pp. 85-100.

Romney, M.B. & Steinbart, P.J. (2003). *Accounting Information Systems*. Ninth Edition (International Edition), Pearson Education Inc., Upper Saddle River, New Jersey, United States of America.

Roy, B. (1990). Decision-aid and decision-making. *European Journal of Operational Research, Vol. 45*, No. 2-3, pp. 324-331.

Scheer, A.-W. (1994). *Business Process Engineering – Reference Models for Industrial Companies*. Springer-Verlag, Berlin, Germany et al.

Scheer, A.-W. (1999). *ARIS – Business Process Frameworks*. Third, Completely Revised and Enlarged Edition, Springer-Verlag, Berlin, Germany et al.

Scheer, A.-W., Thomas, O. & Adam, O. (2005). Process modeling using Event-Driven Process Chains. In: Dumans, M., Van der Aalst, W. & Ter Hofstede, A.H.M. (Eds). *Process-aware information systems – bridging people and software through process technology*. John Wiley & Sons, Hoboken, New Jersey, United States of America.

Schouten, P., Delen, G. & Hoogeveen, D. (2007). *Workshop Europees Aanbesteden.* Presentation of Verdonck Klooster & Associates for Capgemini Outsourcing. Held at March 30, 2007.

Shaw, M.J., Subramaniam, C., Tan, G.W. & Welge, M.E. (2001). Knowledge management and data mining for marketing. *Decision Support Systems, Vol. 31*, No. 1, pp. 127-137.

Somers, T.M. & Nelson, K. (2001). The Impact of Critical Success Factors across the Stages of Enterprise Resource Planning Implementations. *Proceedings of the 34th Hawaii International Conference on System Sciences.*

Steehouder, M., Jansen, C., Maat, K., Van der Staak, J., De Vet, D., Witteveen, M. & Woudstra, E. (1999). *Leren Communiceren – Handboek voor mondelinge en schriftelijke communicatie*. Vierde Geheel Herziene Druk, Wolters-Noordhoff, Groningen, the Netherlands.

Szulanski, G. (1996). Exploring internal stickiness: impediments to the transfer of best practice within the firm. *Strategic Management Journal, Vol. 17*, Special Issue: Knowledge and the Firm, pp. 27-43.

Taghva, K., Borsack, J., Nartker, T. & Condit, A. (2004). The role of manually-assigned keywords in query expansion. *Information Processing and Management, Vol. 40*, No. 3, pp. 441-458.

Thiadens, T. (2005). *Manage IT! Organizing IT demand and IT supply.* Springer, Dordrecht, the Netherlands.

Venkatesh, V. & Davis, F.D. (1996). A model of the antecedents of perceived ease of use: development and test. *Decision Sciences, Vol. 27*, No. 3, pp. 451-481.

Venkatesh, V. & Davis, F.D. (2000). A theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science, Vol. 46*, No. 2, pp. 186-204.

Venkatesh, V., Morris, M.G., Davis, G.B. & Davis, F.D. (2003). User acceptance of information technology: toward a unified view. *MIS Quarterly, Vol. 27*, No. 3, pp. 425-478.

Watson, I. (1999). Case-based reasoning is a methodology not a technology. *Knowledge-Based Systems, Vol. 12*, No. 5-6, pp. 303-308.

Wixom, B.H. & Watson, H.J. (2001). An empirical investigation of the factors affecting data warehousing success. *MIS Quarterly, Vol. 25*, No. 1, pp. 17-41.

Yang, Z., Cai, S., Zhou, Z. & Zhou, N. (2005). Development and validation of an instrument to measure user perceived service quality of information presenting web portals. *Information & Management, Vol. 42*, No. 4, pp. 575-589.

Zanakis, S.H., Solomon, A., Wishart N. & Dublish, S. (1998). Multi-attribute decision making: A simulation comparison of select methods. *European Journal of Operational Research, Vol. 107*, No. 3, pp. 507-529.

Zollo, M. & Winter, S.G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science, Vol. 13*, No. 3, pp. 339-351.

Websites

Copernic (2008). Copernic website. Available at http://www.copernic.com.

Data Model (2005). *Data Model Cardinality.* Last updated May 2, 2005. Available at http://www.datamodel.org/DataModelCardinality.html.

Dick, B. (1997). *Approaching an action research thesis: an overview.* Last updated August 15, 2005. Available at http://www.scu.edu.au/schools/gcm/ar/arp/phd.html.

Scopus (2008). Available at http://www.scopus.com/scopus/home.url.

Vaishnavi, V. & Kuechler, W. (2005). *Design Research in Information Systems.* January 20, 2004, last updated August 4, 2007. Available at http://www.isworld.org/Research-design/drisISworld.htm.

Web of Science (2008). Available at http://apps.isiknowledge.com.

Appendix A – Descriptors used in Reference Tracking System

The sectors with their industries:

- Energy, Utilities, and Chemicals
  - Chemicals
  - Energy
  - Mining
  - Oil and Gas
  - Utilities
  - Waste
- Financial Services
  - Diversified Financial
  - Insurance
  - Investment Banking
  - Retail Banking
- Government
  - Defense
  - Education
  - Healthcare
  - Public Finance and Tax
  - Public Security
  - State, City and Regional
- Life Sciences
  - Agro Chemicals
  - Biotechnology
  - Medical Devices
  - Pharma
- Manufacturing, Retail, and Distribution
  - Aerospace and Defense
  - Automotive
  - Consumer Products
  - Distribution
  - General Manufacturing
  - High Tech
  - Retail
- Telecom, Media, and Entertainment
  - Entertainment
  - Media
  - Telecoms
- Other Services
  - Business Service
  - Travel and Transport

Disciplines of Capgemini:
- Consulting Services
- Technology Services
- Outsourcing Services

Offers and sub offers of Capgemini Outsourcing (OS):
- Application Management (AM)
    - Bespoke
    - ERP
- Business Process Outsourcing (BPO)
- Infrastructure Management (AM)
    - Data Centre Services (DCS)
    - Desktop and Distributed Services (DDS)
    - Network Infrastructure Service (NIS)

The regions of Capgemini:
- Asia Pacific
- Benelux
- Central Europe
- France
- Iberia
- Italy
- Nordic
- North America
- UK & Ireland

Confidentiality levels:
- Green status: Capgemini has permission from the client to use the client name and project information as described in the form for external use. This does not include permission to use the client's logo. For permission to use the logo, please contact the engagement director.
- Blue status – default: Capgemini can share engagement information, but must replace the client's name with a generic description e.g. "Large Telco Provider".
- Orange status: Account Manager must be contacted prior to using engagement information externally (name, logo or project description).
- Red status: Capgemini must not share information about this project for any external purposes (name, logo or project description).

Appendix B – Entity-Relationship Diagram

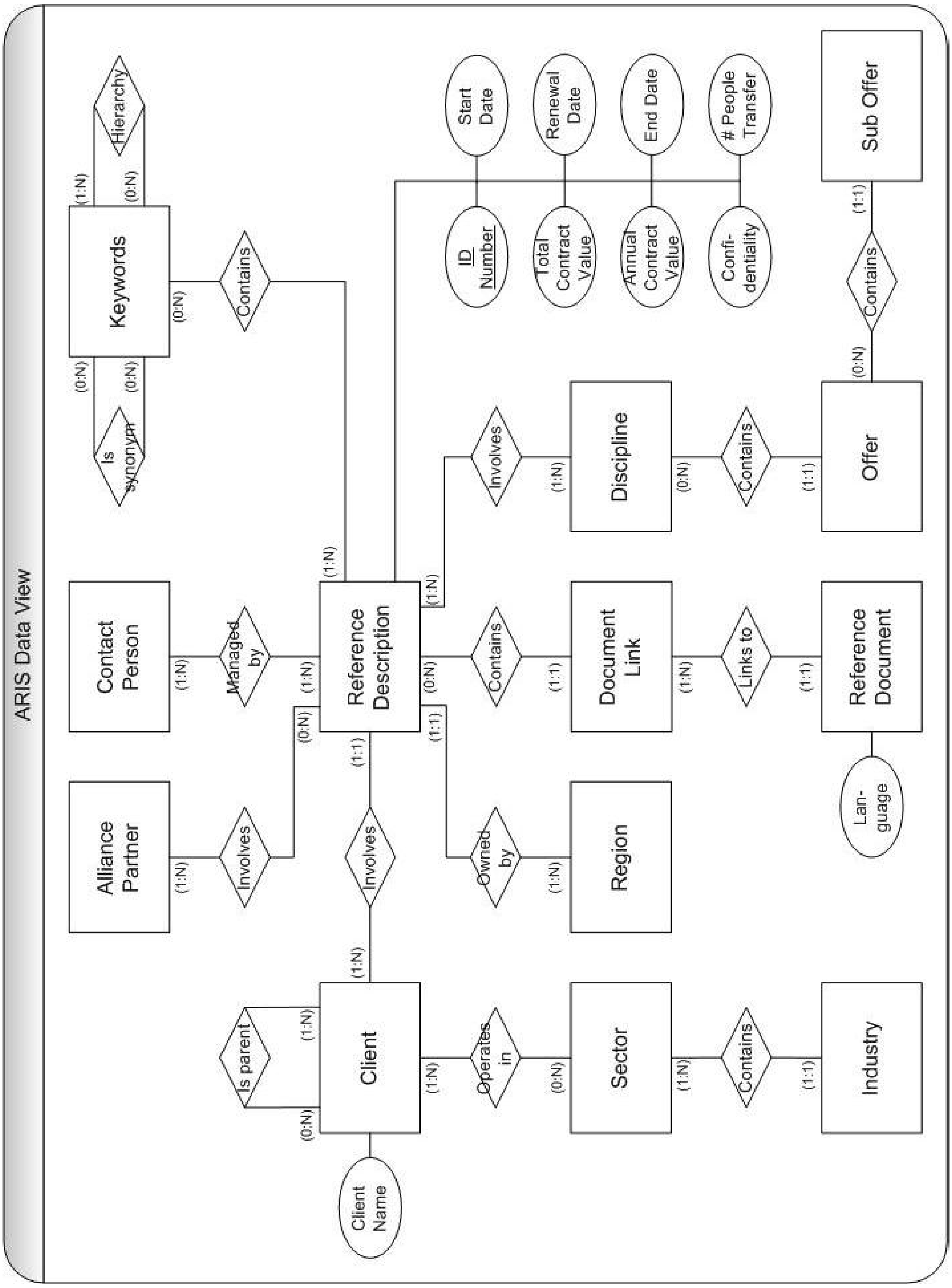


Figure 37: Full page Entity-Relationship Diagram of the content of the reference library

Appendix C – List of keywords

The alliance partners, key technologies and other keywords currently used in the Reference Tracking System are in Table 9

.NET	CICS	Enterprise Architecture
24 x 7 Monitoring	Cisco	Equinix
24 x 7 Support	Citrix	Exact
Accenture	Client Experience	Expertise
Adobe	CMM	France Telecom
Agility	CMMI	Fujitsu
Alfa	Cobol	Functional Management
Application Lifecycle Management	Cokopas	Functional Support
Application Service Provider	Continuity	Geographical Information System
Architecture	Cost Reduction	Getronics
AS400	COTS	Global Service Desk
ASP	CRM	Google
Atos	Database Management	Green Desktops
Audit	DEC	Hardware Maintenance
Authentication	Dell	Health Check
Availability	Delphi	Hosting
Bespoke	Desktop Management	Housing
Biztalk	Desktop Support	HP
Blade	Digital	HRM
Bonus Malus	Disaster Recovery	HTML
BT	Document Management	Hyperion
Built - Run	Documentum	i3
Bull	Dual Data Center	IBM
Business Critical Applications	Due Dilligence	IBM Websphere
Business Intelligence	E-Commerce	ICL
C	E-Government	ILOG
C++	EDI	Incident Management
Capacity On Demand	Efficiency Improvement	Industrialization
CAPM	Electronic Client Dossier	Infosys
Certification	EMC	Innovation
Change Management	Enterprise Application Integration	Integration

Table 9: Keywords used in the Reference Tracking System

Integrity	Problem Management	SQL
Intel	Program Management	SQL Integrator
Intimacy	Progress	Standardization
ITIL	RAD	Storage
ITP	RAPID	Storage on Demand
J2EE	Rapid Data Capture	Successful Retransition
Java	Real-time Database Management	Successful Transfer
JD Edwards	Reduce Time To Market	Successful Transformation
Knowledge Management	Reliability	Successful Transition
Kofax	RFID	SUN
LAN	Rightshore	SUN Solaris
LDAP	Risla	Supply Chain
Legacy	Run - Built - Run	Sybase
Lenovo	RUP	Tandem
License Management	SAN	Tata
Lighthouse Systems	SAP	Technical Management
Linux	Satellite Navigation	Technical Support
Logica	SCC	Technovision
Lotus	Second Line Support	Telephony
Lynx	Security	Third Party Contracts
Mail Environment	Service Desk	Tibco
Mainframe	Service Improvement	Unified Project Management
Microsoft	Service Oriented Architecture	UNIX
Normática	Sharepoint	Versatel
Novell	Siebel	Visual Basic
Office Automation	Siebel Bespoke	VMC
Operational Excellence	Siemens	VMWare
Oracle	Simac	VoIP
Oracle Bespoke	Smart Metering Service	WAN
Oracle Database	SOAP	Webhosting
Ordina	Softgrid	Webservices
PeopleSoft	Software as a Service	Wipro
Powerhouse	Software Development	Xansa
Primus	Software Integrators, Ltd.	XML
Privacy	Sogeti	

Table 9 (continued): Keywords used in the Reference Tracking System