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Mobile Knowledge Management Support in Fire Service Organisations

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Abstract

In emergency domains like fire services, the need for support systems enabling instant mobile access to mission-critical knowledge from different heterogeneous knowledge sources has increased significantly during the past years. A comprehensive socio-technical study that focuses on the current state of working and on the needs of the people working in fire services was conducted within the European Project AMIRA (Advanced Multimodal Intelligence for Remote Assistance). Based on the results of this study, the AMIRA system was designed, which supports knowledge management by a system that integrates various knowledge sources through an intelligent mediator component called CAKE (*Collaborative Agent-based Knowledge Engine*). The knowledge can be assessed through multi-modal mobile and stationary clients. The developed system has been implemented as prototype and successfully evaluated in a comprehensive evaluation based on user trials.

1 Introduction

In recent years, the demand for support systems for emergency services, such as fire services, has increased significantly in order to improve methods for all types of protection. Today, a focus is put on training, qualifying and supporting the members of emergency services, but there is also an increased awareness of the potential of systematic knowledge management. In particular in fire service organisations, there is a demand for supporting inexperienced *Incident Commanders (ICs).* As first attendance at incident grounds, ICs are in charge of the fire crew and are required to make dynamic decisions in a safety and risk critical environment, utilising a range of skills in a time critical manner. This decision making process can be improved by providing knowledge of different kinds, for different purposes, and from different sources, according to the particular emergency situation. This knowledge provision is embedded in a collaborative process and involves several people in the fire service working with different roles in different locations. To address this challenge, the European AMIRA (Advanced Multimodal Intelligence for Remote Assistance) R&D project was initiated. AMIRA has particularly the objective of developing advanced knowledge-based, mobile support techniques integrated with recent speech and search technology. The resulting technology aims at supporting users by obtaining and providing knowledge for making decisions in time and business critical situations.

To establish a solid ground for the development of such a knowledge management technology, a comprehensive analysis of the requirements of fire service organisations has been performed. It was necessary to analyse in advance what the actual needs of users in fire service organisations are, what they use today, and what they could realistically need to use tomorrow. Particularly, the flow of information within fire service organisations was analysed with the goal to improve information exchange among the collaboratively working fire service staff in the future. This socio-technical study has been conducted in close collaboration with the *Fire Services College (FSC)*, which is the UK governmental training and research centre establishment for UK fire services. Based on this requirements analysis, the AMIRA system has been designed and implemented. It supports knowledge management through a support system that integrates various knowledge sources through an intelligent mediator component called CAKE (*Collaborative Agent-based Knowledge Engine*). The people involved in a fire service organisation can access all the available knowledge through multi-modal mobile and stationary clients in their particular working environment.

The remainder of the paper is organised as follows. Section 2 presents the main results of the socio-technical study. Section 3 sketches the AMIRA system, which is evaluated in detail in Section 4. Finally, a short conclusion closes this paper.

2 Socio-technical Study

The goal of the socio-technical study is to elicit the user needs of fire service members with respect to optimisations of their current state of working. In accordance with human behaviour, user opinions and working conditions three points were figured out that had to be taken into consideration to reach the analysis goal: analysis of the current state of working practices, elicitation of user requirements, and development of use cases. Based on these points a methodology consisting of four different analysis levels was designed:

- **Information source interrogation and analyses**: analysis of existing documentations, studies, and data sources;
- **Interviews and questionnaires**: knowledge acquisition from users;
- **Requirement assessment**: elicitation of user requirements and use cases;
- **Requirement evaluation**: verification of the requirements and use cases.

This methodology was also aligned to socio-technical research in information society [Huws02, Huws04, Soci02] for ensuring a comprehensive view on user needs. In the following the main achievements of the conducted socio-technical study [FrBe05] are presented.

2.1 Current State of Working Practices

For elaborating the current state of working practices, related projects, available documents and existing studies (e.g. a study from the "Chief and Assistant Chief Fire Officers Association" (CACFOA) [CACF01]) were analysed. Furthermore, questionnaires were developed that were specially tailored to young ICs in order to acquire knowledge about user needs and to uncover deficiencies in terms of the required support for ICs. These questionnaires and interviews were conducted at FSC at which representatives of different UK fire services took part. Altogether 78 fire fighters and ICs were involved in the interviews and debriefings. As a result, several typical important skills of people involved in fire service organisations were identified [FrBe05]:

- Keen perception for capturing situations;
- Flexible acting in a fast changing environment;
- Retaining facts in memory;
- Collaborative working.

Both, the first and the second skill is highly time critical in emergency situations and is needed at both the incident ground and the supporting level in terms of fire control personnel and human experts. Keen perception for capturing situations is the precondition for identifying the nature of incident and further for recognising signs for special dangers, i.e. hazardous materials, leaking vessels and poisons. By ignoring such signs, fire fighters take a risk of misconceiving incidents that could lead to a crucial issue. Above all, it depends on the reports of the fire fighters how ICs make their decisions. Beyond keen perception, fire fighters have to cope with occurring external events having impact on their decisions and incident procedures.

The third skill concerns long-term processes with which fire fighters have to cope. Because of complexity and diversity of incidents, fire fighters have to retain much knowledge about their operations. It is hard for fire fighters to keep such a lot of facts in their minds and to undertake further study, particularly for novices or fire fighters who work in the auxiliary fire brigade.

The last skill addresses all kinds of collaborative working during operations, e.g. information exchange between colleagues and the collaboration with experts. When ICs are not sure in making a decision they request experienced colleagues or fire control for support; communication is a big issue in fire services.

Another result in terms of current state of working practices was that over 30 knowledge sources are in use during work, e.g. operational notes, fire facts, incident information, location information [FrBe05]. Some knowledge sources are only available on papers, other knowledge sources can be accessed via electronic devices, and colleagues or human experts can be seen as knowledge sources as well. Usually, for fire fighters who wear their working clothes it is very cumbersome to access these knowledge sources and, additionally, they have to be aware what kind of information is provided by what knowledge source.

2.2 User Requirements

User requirements were deduced from information source interrogations and from the conducted interviews. Because different fire services have different requirements, only those requirements that are common between UK fire services are presented. Analysis of the interview transcripts and questionnaires highlights several specific issues [FrBe05]. One main issue is the surfeit of knowledge sources that are in use in fire service organisations. Some fire fighters talk about the danger of information overload or overflow. Due to this overload of information, a large number of text-based documents have to be read in order to determine the specific information wanted. In summary, the following requirements were identified:

Information support (R1): ICs should be supported with information and working instruction for decision making. Only ICs demand such support because fire services are hierarchically structured, so that other fire fighters involved in the incident should get information only from the responsible IC.

Mobility (R2): For supporting mobile workers, the envisaged information support must be able to provide information at any location the mobile worker can be: Mobile access is needed. While working in time and business critical processes, mobile workers demand short response time regarding information support.

Ease of use (R3): The usability of the envisaged computer support has to be aligned to the requirements during work, e.g. that fire fighters wear operational kits, such as helmets, goggles or breathing apparatus and thick gloves. The information support enables users to smoothly access information by a hands-free access. One solution is the integration of a speech dialogue system via which the ICs are able to access the information support system.

Core information (R4): The IC may not be suitably supported by highly complex information because there is no time to analyse the information in action. An overload of information has to be avoided; the emphasis must be on the concise, easily understandable core information.

Reduction of the number of systems in use (R5): Because of a large number of information sources and different access methods there is a need for reducing the number of systems in use for facilitating improved working on location.

Search on structured and unstructured data (R6): For integrating the existing information sources, the envisaged system requires sufficient integration methods due to disparate formats of information, e.g. structured or unstructured.

Knowledge exchange and collaborative working (R7): It is crucial to consider information paths within organisations: The control centre which coordinates mobile workers in action is lacking information from the field. Therefore, an enhanced information support is demanded that allows notifications and collaboration among users.

Pro-active information support (R8): In relation to the current work, the fire control lacks information about what is going on in the field. Hence, they should be pro-actively supported in getting information about their operatives.

Integration of best practices (R9): Novices and inexperienced users often lack sophisticated knowledge about *how* to assess the required knowledge in a time-efficient manner and how to avoid irrelevant results. Therefore, they need support to perform an adequate search process.

Information capturing (R10): Based on the interviews conducted, a need for procedures to update existing information sources becomes obvious. Up to now, update processes are not executed very frequently, so that knowledge sources may become less reliable. Structuring of update and review procedures would be a huge benefit for fire service domains.

User profiles (R11): User profiles are required that ensure the users' authenticity and authorisation.

This list of user requirements is not exhaustive but establishes an understanding of user needs within the fire service organisations. In the scope of this paper, the requirement R9 is of particular importance: The reuse of search processes demands process support in order to provide means of efficient combining result items from different information sources.

2.3 Use Cases

The main goal of the socio-technical study is the research of appropriate ways to integrate and enhance knowledge management in order to support mobile workers during collaborative work. The development of a prototypical AMIRA system as demonstrator of the results is one of the main outcomes. The system implements three use cases tailored to the user requirements.

2.3.1 Use Case 1: IC requests information via a speech dialogue system

Within the fire services the IC is the only person who is in charge and responsible for the decisions made at the incident. Therefore, all fire fighters involved provide her/him with precise details of the incident. The IC is then able to make decisions on how to proceed. Consequently, there is a need to support the IC when he lacks information necessary for decision-making and in estimating current resources. Instead of going back to the fire appliance, the IC should be supported in requesting information and receiving answers by using a mobile system which can be requested by speech. Figure 1 shows the first use case.

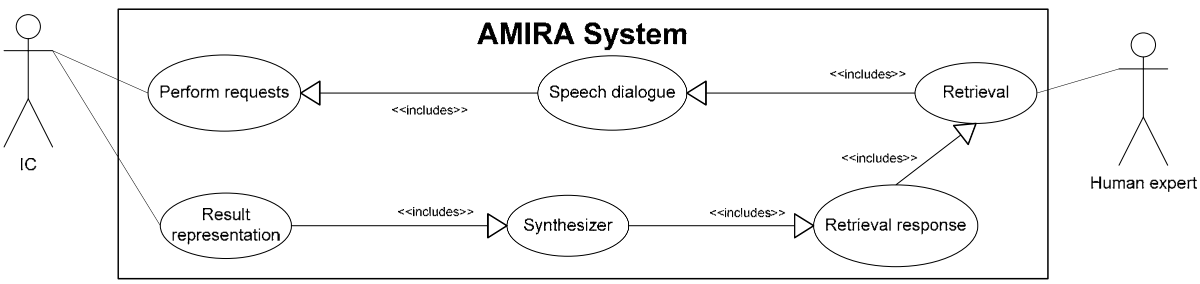

Figure 1: Use Case 1 represented as UML Use Case Diagram (please note that the arrows do not represent the flow of information but the inclusion of separately described sub- use cases)

One possible scenario of this use case is when the IC arrives at the incident, fire fighters tell him many facts about the incident but he does not know how to interpret the facts or how to act. For example, an inexperienced IC and his crew come to a road traffic accident where a truck is involved labelled with an *emergency action code (EAC)* indicating dangerous goods. The IC is not sure of the encoding, so that he uses the AMIRA system to perform a query which includes the EAC and a description of the accident like ‘vehicle accident’ and ‘fire affecting or likely to affect load’. To articulate the information request the IC uses a speech dialogue system as illustrated in Figure 1. After that the AMIRA system initiates a retrieval based on the information request. In the retrieval process human experts can also be involved. Finally, the retrieval response is synthesized into speech and presented to the IC. Thus, the IC receives instructions how to act and what has to be taken into consideration for further decisions.

2.3.2 Use Case 2: pro-active information support

By monitoring user-system interactions, the AMIRA system can elicit information directly related to the operation in which the operatives are currently working. By analysing this information, the AMIRA system is able to pro-actively support the fire control (working in the fire service headquarter) with information about the situation in the incident ground as shown in Figure 2. During or after the operation this information can be used as part of the operation debrief protocol or for reproducing actions or decision made during operation.

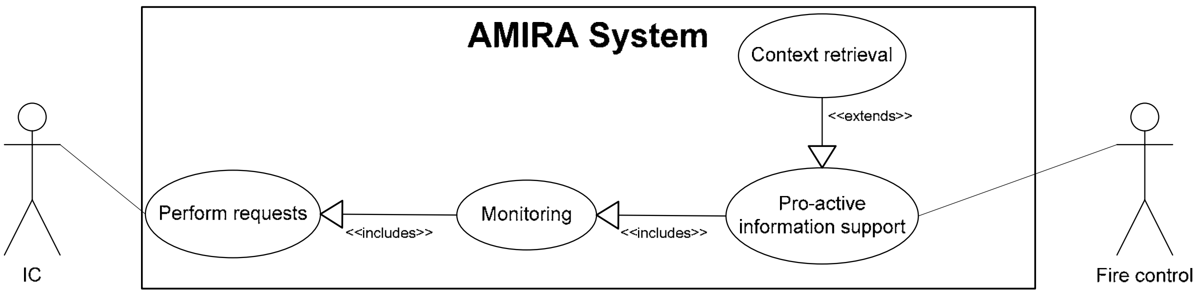

Figure 2: Use Case 2

For instance, in time critical situations it is imperative that the fire control is fully aware of the activities of fire fighters involved in the incident. Therefore, the information requests performed by the IC are of particular importance to the fire control: All requests are monitored and pro-actively delivered to the fire control. Beyond that, the system is able to retrieve additional context information by retrieving more information based on the monitored facts.

2.3.3 Use Case 3: post-incident analysis

Collaborative post-incident analysis of operations is managed by the AMIRA system. This encompasses pro-actively asking involved persons (control, IC and fire fighters) for information about their last actions concerning possible modifications to guidelines or work instructions.

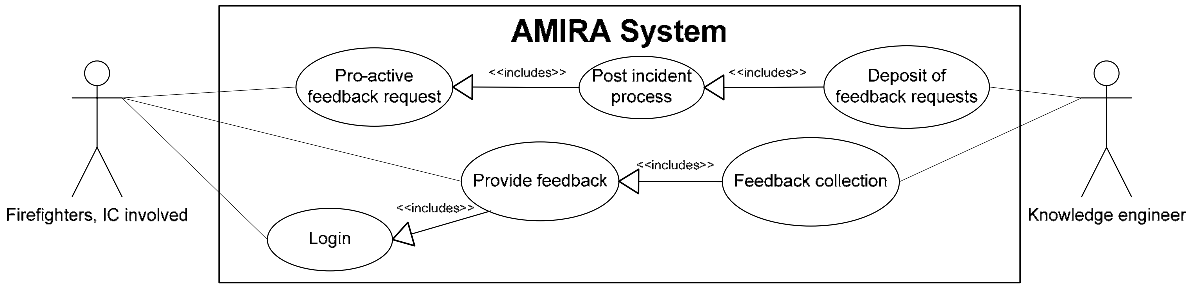

Figure 3: Use Case 3

After an incident a knowledge engineer initiates a post-incident process. Regarding the incident he/she requests feedback from the persons involved. The post-incident process sends the feedback request to all persons involved in the particular incident. Then the fire fighter or IC logs in the AMIRA system and formulates his/her feedback, which is collected in a repository. Later on, a knowledge engineer is able to access this repository, to analyse the reports, and – if necessary – to modify the information sources available within the organisation.

3 The AMIRA System

According to the socio-technical study, a knowledge management support for collaborative and mobile working was designed and realised through the AMIRA prototype system. Due to the space limitations of this paper, only short technical overview on the system is given here, focussing on the means for implementing the user requirements.

3.1 Overview

The fundamental idea of the system is to combine knowledge management with speech dialogue and search technology as depicted in Figure 4. For this purpose the *Collaborative Agent-based Knowledge Engine (CAKE)*[1] [FrMS05] has been developed. Beyond the ability to integrate various technology components (R5), CAKE interfaces with speech dialogue and

[1] For further details see also: http://www.wi2.uni-trier.de/de/cms/projects/Cake/

search components and acts as a mediator between them in order to guide searching on multiple information sources (R1). To support a seamless integration into working procedures, a speech dialogue component (R3) provides a mobile interface (R2) which can be used by ICs to articulate information demands. To make existing information sources accessible, appropriate search components can be connected to CAKE, so that heterogeneous information sources are integrated (R6) (e.g. search engines, knowledge bases, human experts) [Freß05].

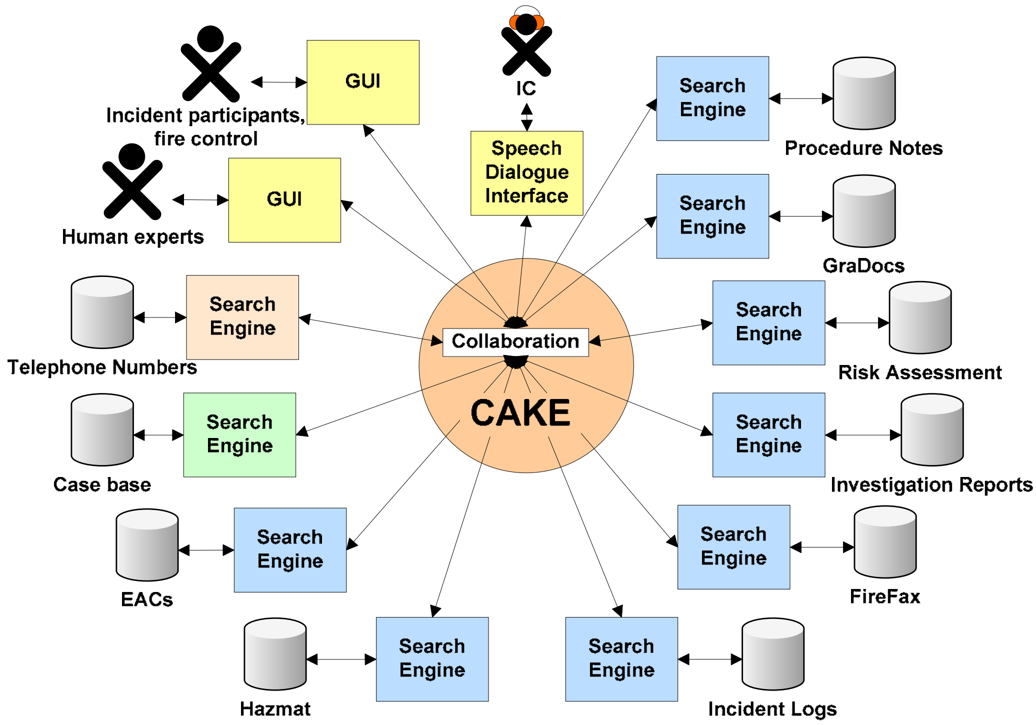

Figure 4: Architecture of the AMIRA System

In the AMIRA context, a sophisticated search engine from Fast DataSearch[2] provides indexing and searching of unstructured documents or data archives. Instead of indexing the whole documents only, this search engine supports the search of document fragments, called 'scope search'. This avoids the retrieving of long and verbose documents; focusing instead on the most important 'scope' of the document (R4). Secondly, Kaidara[3] Software provides a search engine based on a structural case-based reasoning approach [BABG04] and enables a search on past experiences that are represented by highly structured data in form of cases.

To access the system, *graphical user interfaces (GUIs)* are provided for human experts, fire control staff, and incident participants. This GUI which can be used on different stationary and

[2] www.fast.no
[3] www.kaidara.com

mobile devices such as tablet PCs and PDAs, allows these experts to answer ICs' requests (R7). The fire control staff is pro-actively supported via a GUI (R8) and the incident participants can use a GUI in order to log in (R10) and to formulate feedback (R11).

Besides the user interfaces, Figure 4 also shows an excerpt of the information sources available in UK fire service organisations: chemical database ChemData, UN numbers (hazardous substances), procedure notes, EACs, human experts who answer information requests while doing their daily office work, etc. These information sources are related to special purposes and normally do not overlap each other by content, so that the competence area of each information source can be characterised differently. Consequently, the need for a meta-search process implementing efficient search strategies becomes obvious (R9). For example, clever search processes only request a relevant selection of available information sources and efficiently combine result responses retrieved from different information sources. The usage of such search processes enables novices to reuse search strategies of experienced users.

3.2 Unified Data Model

Mediating between search components and user interface components, CAKE addresses the challenge of dealing with differently structured search queries and search results of multiple information sources. In order to transport various queries and results through CAKE, it includes a flexible and unified data model which is constructed in an application specific manner according to the structure of the available knowledge sources and the supported types of queries. This *CAKE Data Model* describes all kinds of data that occur in the system. It is based on object-oriented modelling techniques and makes use of specialisation and aggregation. Available built-in data classes for model construction are atomic classes like Boolean, integer, double, date, or time as well as compound data classes such as aggregates, collections, and intervals. These so called *system classes* are used to define the application specific data model. We call this model a *unified data model* because it unifies all data formats and structures which occur in the AMIRA system in a consolidated structure. Queries and search results from the various GUIs and the speech dialog system are mapped to this data model and the various search engines are connected to the AMIRA system by means of wrapper agents that map the specific representation of the respective search engine to the data model. As a consequence, the unified data model allows to capture disparate search results and to transport these results within the AMIRA system.

3.3 Collaboration Patterns

The idea of integrating former search experiences in the form of processes is of particular importance in order to fulfil the requirements R1, R3–R6 and R9. Therefore, CAKE incorporates workflow technology [Freß05] in order to support real-world processes in general and search processes in particular. The process support allows different information sources to be requested in several steps and to stop when the search results have satisfied the request. A search process can be viewed as a collaborative process conducted by several search components in order to achieve a common result set. Within CAKE such collaborative processes are realised as so called *collaboration patterns* which are a specialisation of workflow definitions describing collaboration between workflow participants (humans and/or machines) based on best practice. Users are supported by collaboration patterns in automatically selecting appropriate information sources with respect to the current information need. Among other details, those search processes include information about which sources are relevant, which distribution techniques for the current query should be used, and how the result should be merged by use of well known methods from distributed information retrieval [Call00]. Figure 5 illustrates an example of a collaboration pattern.

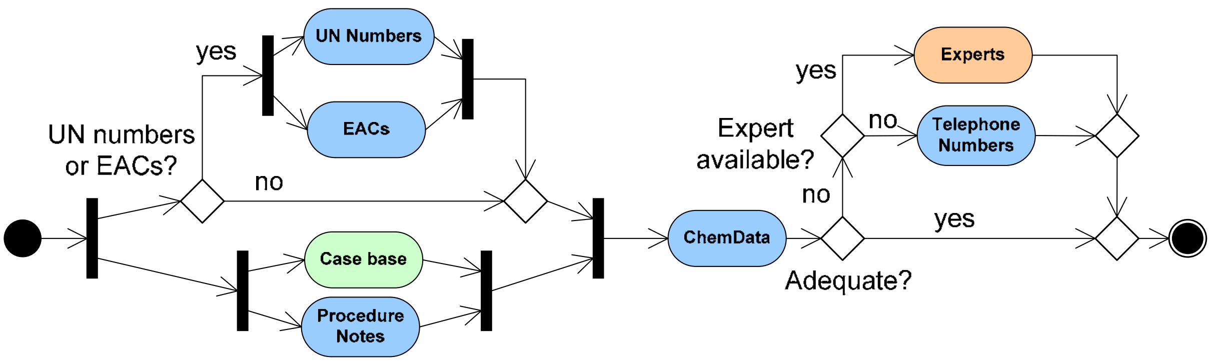

Figure 5: Example of Collaboration Patterns represented as UML Activity Diagram

According to the scenario described in the first use case, this collaboration pattern comprises information sources relevant to road traffic accidents involving hazardous materials. The processing of the pattern is as follows. Firstly, the case base and the procedure note collection are requested. Concurrently, the query is checked for EACs and UN numbers. If the query contains such encodings, information about EACs and/or UN numbers is retrieved. After that, the ChemData collection is requested. The retrieval does not need to be based on ICs query directly but on data retrieved from the first collections, so that additional information can be received in order to provide inexperienced ICs with more context information. Finally, in order to ensure useful results, either human experts can be requested or experts' telephone numbers can be retrieved if no adequate result items have been achieved so far.

This is only one example of a collaboration pattern. According to the socio-technical study many best practices were encountered and hence several specific collaboration patterns were collected. Each pattern describes a search process for a particular kind of information request and is characterised by a meta-data description of the information requests for which it is appropriate (*collaboration pattern characterisation*). Consequently, for each individual request it is necessary to select the best possible collaboration pattern. CAKE incorporates special case-based retrieval component which automatically select an appropriate collaboration pattern with respect to the users' information request [Freß05]. In a nutshell, this retrieval process works as follows: After the IC performed an information request, the incoming request is analysed for keywords pre-defined in the unified data model. The keywords are used as query input for a similarity-based retrieval [FMMS05] allowing the request and available collaboration pattern characterisations to be compared at the semantic level. The most suitable collaboration pattern is then initiated for processing the current request. To translate the query for each underlying knowledge source, CAKE uses the unified data model.

4 Evaluation

In order to assess the AMIRA system against the socio-technical study, an evaluation based on 19 field trials were conducted between May and June 2006. Besides user requirements and use cases, conceptual aspects like collaboration patterns were also objects of evaluation. The use cases acted as starting points during the design of the trials and they were used as guidance to verify the expectations suggested by the socio-technical study. A further aim of the evaluation was to assess to what degree the user requirements were met. Therefore, hypotheses were formed and assessed in conjunction with domain experts.

4.1 Evaluation Design

In literature many evaluation methodologies are available. The presented evaluation design was developed in accordance with existing evaluation approaches and methods [Nati06, LaLS06] in order to evaluate the AMIRA system in the particular field of collaborative and mobile working. The evaluation design includes a methodology which specifies the conduction of field trials.

These trials are appropriate for testing the system in remote locations and under real-world conditions. Field trials are field experiments and build the basis for testing the ability, quality and performance of the AMIRA system. Based on these trials, conclusions established by observation and user opinions can be drawn in order to obtain an overall evaluation of the AMIRA system. The underlying evaluation methodology is divided into four steps:

1. Definition of concrete scenarios
2. Elaboration of questionnaires focused on scenarios, use cases and user requirements
3. Trial procedure consisting of three phases
   (a) Conduction of trials with the AMIRA system at work
   (b) Conduction of debriefs, interviews and questionnaires
   (c) Intermediate trial analysis
4. Analysis of debriefs, interviews and questionnaires.

Concrete scenarios have been precisely delineated because they have direct impact on user instruction and field trials. Elaborating a questionnaire ensures the particular focus on the objects of interests and the consideration of the scenarios, use cases and user requirements. Questionnaires had to be well organised and carefully prepared because this step determines the data which is collected about the trials and which build the basis for analysis.

4.2 Evaluation Results

Field trials were conducted at the Avon Fire & Rescue Service, at Westmidland Fire Service and at the Swedish Fire College. At the end of each trial statistical data was collected during the debriefs and interviews which was the foundation of the final analysis. Therefore, several hypotheses to be met by the AMIRA system were formulated in advance and with respect to the socio-technical study. The most important hypotheses were:

- **H1:** The AMIRA system is useful.
- **H2:** The AMIRA system supports useful information.
- **H3:** The AMIRA system is well suited for a decision support system.
- **H4:** The AMIRA system means an added value to incident procedures.

We now present the evaluation results with respect to these hypotheses.

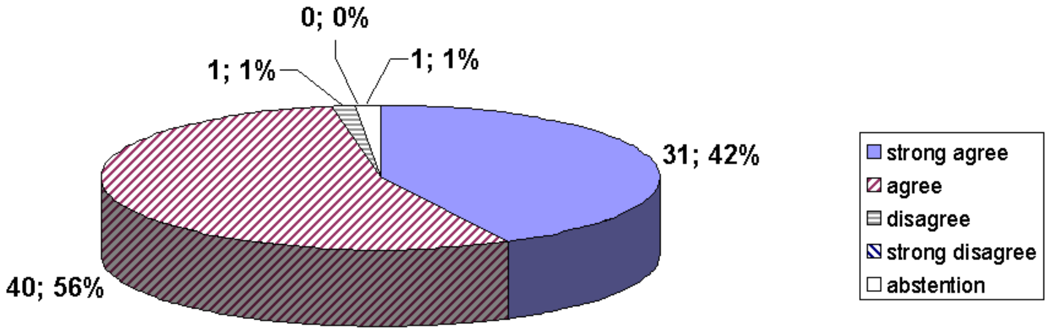

Figure 6: AMIRA system is useful

Altogether 73 fire fighters, ICs and fire service member playing representative roles within fire services are involved in the evaluation process. As depicted in Figure 6 nearly all of them (71 interviewees) agreed or strongly agreed that the AMIRA system was useful for fire service organisations. This leads to subjective evidence that this hypothesis holds.

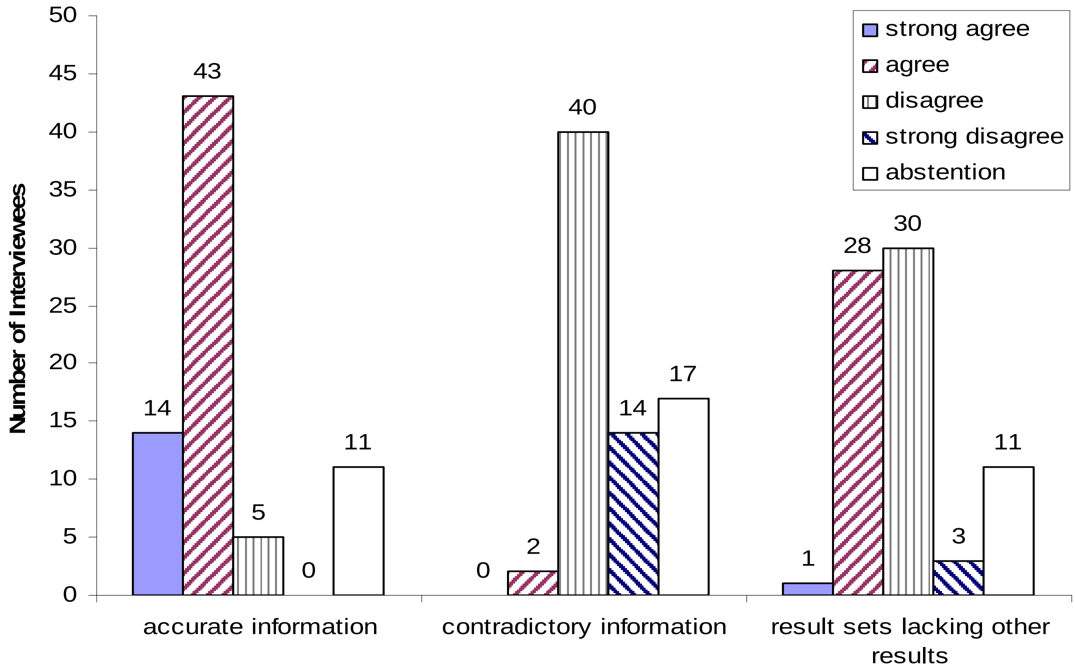

Figure 7: Quality Criteria

The second hypothesis states that the system provides ICs with information of high quality. For collecting opinions about the quality, questions concerning accuracy of information, contradictory information and incomplete result sets were included in the questionnaire. Figure 7 presents the questionnaire results of the quality criteria. Based on the corresponding answers, conclusions about precision and recall could be drawn. A majority of interviewees confirmed that the AMIRA system supported accurate information: 57 interviewees gave positive assessments whereas only 5 persons disagreed. This fact stresses the precision achieved by the retrieved information. Additionally, the interviewees were asked to estimate the percentage of the accurate information: 69% of all interviewees estimated the percentage between 95% - 100%. The next question related to whether contradictory information was retrieved by the AMIRA system. The main trend was to disagree that contradictory information had been retrieved, however 17 abstained from voting. At last, half of the interviewees agreed that the result sets lack other results which would be of particular importance with respect to the current information request. This indicates a deficit in terms of recall but it can be traced back to the prototypical implementation of the AMIRA system, which does not include all organisational information sources.

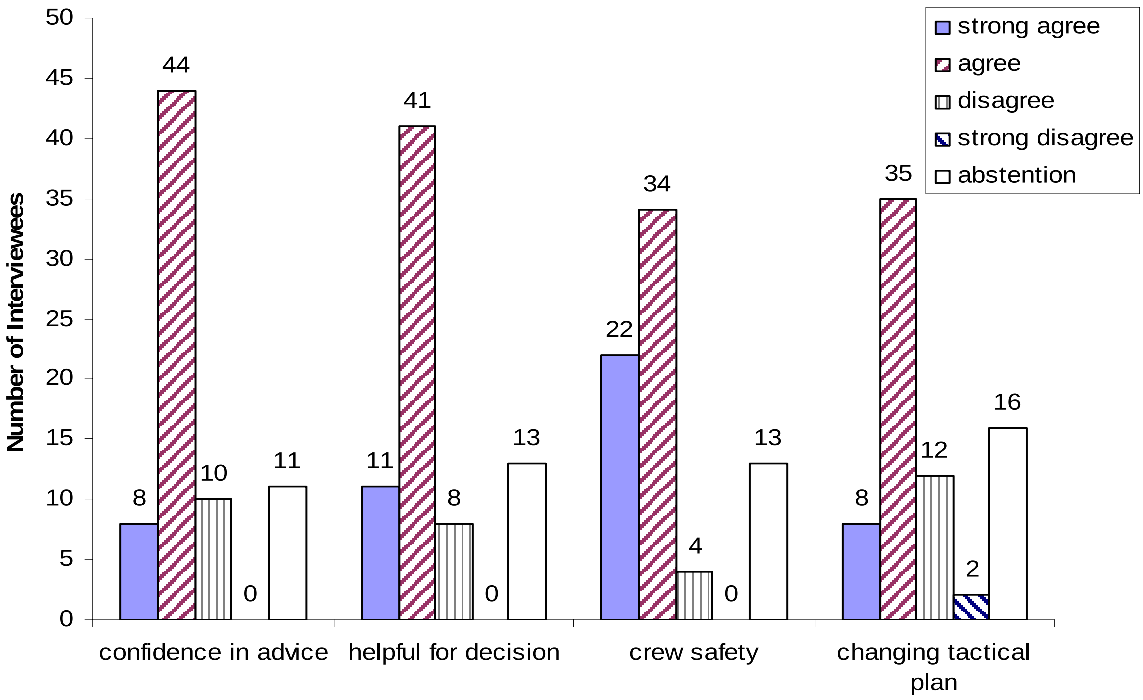

Figure 8: Decision-Making

H3 hypothesises that the AMIRA system is well suited as a decision support system. Therefore, the questionnaire included questions relating to confidence in the AMIRA advice, helpfulness for decision, crew safety and consequences triggered by the advice. All questions were positively assessed as illustrated in Figure 8. One of the most important results was that the interviewees were confident in the advice given by the AMIRA system. This confidence is fundamental for decision making. Beyond that, the advice was assessed as helpful for decision, particularly helpful for resolving the incident. Furthermore, the given advice supported crew safety which is of crucial importance for all fire services. Finally, the interviewees classified the

AMIRA system as decision support system by agreeing that they had changed their tactical plans based on the advice provided. As a result, H3 is agreed with respect to the questionnaires.

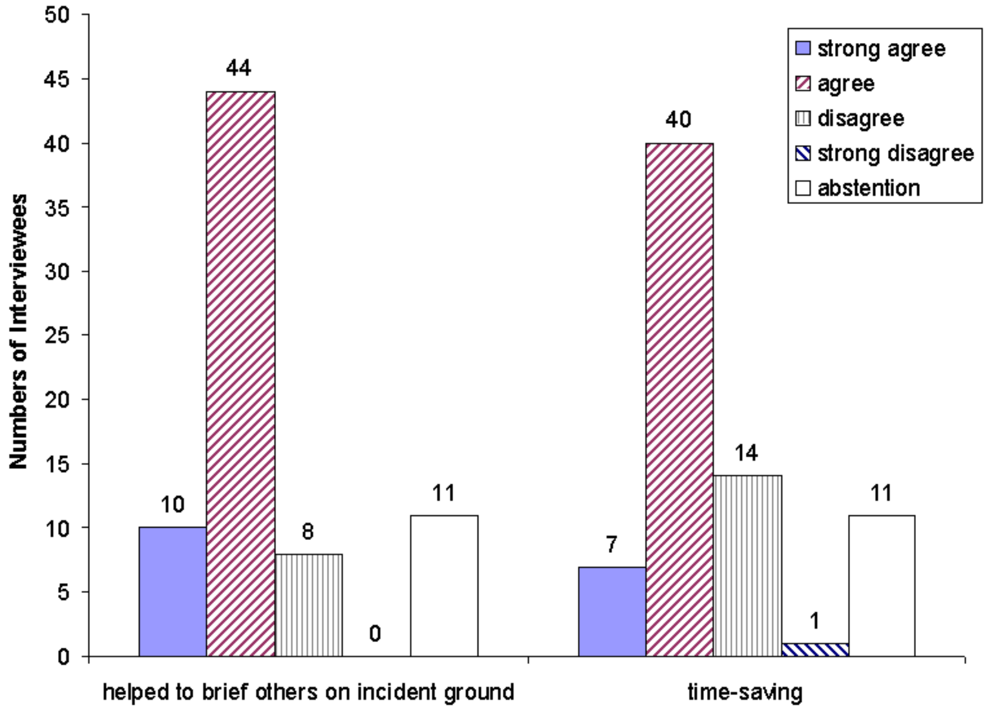

Figure 9: Consequences on Incident Processes

The last hypothesis concerns the consequences triggered by the AMIRA system. The results of the questionnaire are illustrated in Figure 9: On the one hand AMIRA advice helped to brief others on the incident ground and on the other hand time-saving was achieved by this system. Both perspectives are positively assessed by over half of the interviewees, so that H4 holds.

5 Conclusion

In this paper, a case study of developing a knowledge management support in fire service organisations is presented. Based on interviews and questionnaires, a socio-technical study was conducted in order to elaborate user requirements and use cases addressing current user needs and demands in practice. To meet these requirements, a concept of knowledge management support for collaborative and mobile working was developed that allows users and knowledge sources to collaborate in an efficient and user-oriented way. Within the AMIRA project this concept was put into practice and resulted in the AMIRA system. This system realises collaboration of knowledge sources by incorporating collaboration patterns which are based on best practices and formally represent search processes on multiple data sources.

Finally, an evaluation was conducted for assessing the AMIRA system against the socio-technical study. The evaluation process was mainly based on field trials, conducted several times, and questionnaires. Since questionnaires collect user opinion by nature, the evidence of evaluation results was achieved from a subjective point of view. This emphasises the user-oriented approach of the AMIRA project. In summary, the usability of the system is acceptable, but to make it more easily applicable to a busy hands and busy eyes environment, the hardware used need to be developed further to provide a more compact package which is better integrated. Furthermore, the AMIRA system plays an important role with respect to innovation because current information systems applied in fire service organisation do not allow mobile access to ICs. Further results indicate that in the majority of cases, users think that information provided by the AMIRA system would bring incidents to a more effective conclusion and provide for improved crew safety. This will increase efficiency and provide a more cost-effective service to the communities which fire service organisations serve. Finally, strategic managers see this from a different perspective and are intrigued by the possibility of providing experiential knowledge and supporting information to the ICs. They see the emergency response environment as one where organisations are exposed to corporate risk.

Acknowledgement

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Literature

[BABG04] *Bergmann, R.; Althoff, K.-D.; Breen, S.; Göker, M.; Manago, M.; Traphöner, R.; Wess, S.*: Developing Industrial Case-Based Reasoning Applications. The INRECA Methodology. 2. Aufl., Springer, LNAI 1612, 2004.

[CACF01] *Chief and Assistant Chief Fire Officers Association (CACFOA)*: Mobile Data Study. http://www.fire-uk.org/mobdata/study/default.htm verified on 2005-08-05, 2001.

[Call00] *Callan, J.*: Distributed Information Retrieval. In: *Croft, W.B. (Hrsg.)*: Advances in Information Retrieval. Kluwer Academic Publishers, 2000, S. 127-150.

[FMMS05] *Freßmann, A; Maximini, K.; Maximini, R; Sauer, T.*: CBR-based Execution and Planning Support for Collaborative Workflows. In: Workshop "Similarities - Processes - Workflows" on the Sixth International Conference on Case-Based Reasoning (ICCBR 2005), Workshop Proceedings, Chicago, Illinois (USA), 2005, p. 271-280.

[FrBe05] *Freßmann, A.; Bendeck, F.*: Socio-economic Study on User Needs. Technical Report, http://www.wi2.uni-trier.de/publications/2005_technicalReport_D210.pdf, 2005.

[Freß05] *Freßmann, A.*: Adaptive Workflow Support for Search Processes within Fire Service Organisations. In: Proceedings of the 15th IEEE International Workshops on Enabling Technologies: Infrastructure for Collaborative Enterprises. IEEE Computer Society, 2006, p. 291-296.

[FrMS05] *Freßmann, A.; Maximini, R.*; *Sauer, T.*: Towards collaborative agent-based knowledge support for agile projects. In: *Althoff, K.D.; Dengel, A.; Bergmann, R.; Roth-Berghofer, T. (Hrsg.)*: WM2005: Professional Knowledge Management Experiences and Visions. DFKI, Kaiserslautern 2005, S. 383-388.

[Huws02] *Huws, U.*: Towards a Definition of Socio-Economic Research for the RESPECT Project. http://www.respectproject.org/genpapers/definition.pdf verified on 2005-08-05, 2002.

[Huws04] *Huws, U.*: Socio-Economic Research in the Information Society: a user's guide from the RESPECT project. Sussex: Institute for Employment Studies, 2004.

[LaLS06] *Laudon, K. C.; Laudon, J. P.; Schoder, D.*: Wirtschaftsinformatik – Eine Einführung. Pearson Education Deutschland GmbH, München 2006.

[Nati06] *National Science Foundation*. http://www.nsf.gov/ehr/rec/evaldesign.jsp, verified on 2006-07-06.

[Soci02] *Social Research Association*: Commissioning Social Research: a Good Practice Guide. 2. Aufl., London 2002.