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Advanced Multi-modal Intelligence for Remote Assistance

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Thematic priority : Information Society Technologies

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Socio-economic Study on User Needs

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Consortium Composition

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5   The Fire Service College

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PURPOSE

This document presents a socio-economic study for understanding the user needs identified in the two end-user domains that are addressed within the AMIRA project. The identified and validated user needs presented in this study also provides a basis for subsequent AMIRA work packages.

Therefore, this work has the following of aims:

- To meet the Workpackage requirements in the AMIRA Description of Work (Annex 1 of the EC contract) as an enabler for the project partners to deliver their contracted work;

- To be the 'voice' of the two AMIRA end-users in order that the AMIRA project can deliver a useable output that meets the needs of the domains

- To provide the basis for user requirements and use cases in order to specify the interactions between end-users and the envisaged AMIRA system on a non-technical level

This file "210-UTR-D-1.0F" is the final release of the AMIRA socio-economic study of user needs. It may be supplemented with additional detail as the project progresses, especially in the area of current working practices inside the UK fire services, which are currently in the process of change as a result of the Baines Report, commissioned by the UK government in 2003 to review and recommend revised working practices within the UK fire services

Dissemination Level : PU

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1   MANAGEMENT SUMMARY

The socio-economic study of user needs addresses the needs of mobile workers r in terms of computerised support when working remotely, as well as the type of support that their employer organisations are prepared to provide. The two domains representing emergency fire services, through the UK Fire Services College and the vehicle roadside assistance (breakdown repair etc.) sector, through the in-house Transport Engineering Works (TEW) of West Midlands Fire and Civil Defence Authority provide most of the input.

The study starts with a detailed description of the methodology used, which is divided in four analysis levels:

- **Knowledge base interrogation and analyses.** Here, existing knowledge bases and documents are analysed to gain a brief overview of the current state of working, information sources, and end-user skills.

- **Interviews and questionnaires.** Interviews and questionnaires were used for eliciting new knowledge about the end-user domains and for verifying already known domain knowledge. These interviews are described in this study in order to provide a better understanding of the subsequent analysis levels.

- **Requirement assessment.** This analysis consists of the description of the current state of working practices, the list of information sources, and the end-user skills. Based on these issues, a specification is presented of elicited user requirements and use-cases.

- **Evaluation.** The evaluation comprises the validation and verification on behalf of the end-users as well as the project's technology partners.

By pursuing these analysis levels, the presented study primarily focus on the first three levels regarding the fire service domain. In addition to the user requirements, the most important result of the requirement assessment are three use cases that describe interactions between end-users and the envisaged AMIRA system. These use-cases will be addressed by the AMIRA system:

- The first use-case relates to support for Incident Commanders in performing requests and getting answers by utilising a mobile system.

- By monitoring interactions between mobile workers and the AMIRA system, the latter can elicit the context in which the operatives are currently working. Thereby, the AMIRA system is able to pro-actively present context-based information.

- Collaborative, post-incident analysis of an operation can be managed by the AMIRA system. This encompasses pro-actively asking those involved (control command and/or fire-fighters) for information about their actions concerning possible modifications to guidelines or other information used.

Finally, the first results of the evaluation analysis level are represented. This evaluation summarises the differences between the two interim versions of the socio-economic study. Beyond these differences, the agreement concerning presented user needs of both the domain experts and the AMIRA technology partners is described and interdependencies between user needs and AMIRA technologies are pointed out.

2   INTRODUCTION

In recent years, the demand for supporting systems for emergency services has increased significantly in order to optimise methods for all types of protection. Focus is put on training, qualifying, and supporting members of emergency services that can be characterised by business and time-critical processes on incident locations. In that scope, the AMIRA project was initiated to address innovative technologies and their combinations leveraged in high safety of business critical application domains.

The overall goal of the AMIRA project is to provide a multi-modal solution that will significantly improve the accessibility and resources available to support urgent and critical decisions that must be taken by mobile workers, operating individually or in multi-discipline collaborations, at their point of intervention in an event, especially where it may not be possible or feasible to interact directly with a computer keyboard or screen because the operative's hands and eyes are otherwise occupied.

The technical goal of AMIRA is detailed in the Description of Work, which defines also the scope of this study. This goal is to develop a set of reusable components using search, reasoning, speech dialogue technology and collaborative working techniques that can be used to create a variety of applications for use by mobile workers operating in safety or business-critical situations in the field. To achieve this goal, AMIRA is creating a wireless, easy to use, intelligent diagnostic and decision support system for mobile workers.

To fulfil the AMIRA goal, a socio-economic study in critical application domains focuses on the analysis of essential and fundamental user needs including the actual needs of end-users, what do they use today and what do they realistically want to use tomorrow. Demands for computer support need be taken into account to avoid repetition of mistakes made in situations that have occurred previously. .

This socio-economic study of user needs focuses on the challenges, impacts and opportunities in the two domains that can be supported by technologies for providing information and supporting communications. Hence, in association with the domains, solutions focus on daily work within the application domains. This includes the interdependence between human, social, economic, and technological issues encountered in the domains leading to the identification of user needs that are decisive for requirement analysis and for designing information support systems. For eliciting trends of user needs an overall analysis of the application domains is important. The analysis of design requirements, skill requirements, and social requirements helps in understanding user needs that will have a significant impact on the success of information technology solutions.

In the following section the scope of the socio-economic study is defined for addressing the AMIRA requirements. Based on these, an appropriate methodology was then developed and is described in Section 4. According to the methodology, the analysis of existing knowledge bases and documents was executed and is described in Section 5, before a detailed description of interviews and questionnaires, which is presented in Section 5.2. After that, a detailed elaboration of the user requirements presents the main results of the socio-economic study in Section 0. Finally, t results of the evaluation are presented in Section 5.4.

3   SOCIO-ECONOMIC STUDY

Socio-economic research comprises a wide scope of social and economic impacts on products, service offerings, market intervention, and/or on other activities on an economy as a whole and on companies, organisation and individuals [14]. Consequently, many different definitions exist for socio-economics and many different interpretations are used for research. The RESPECT project, [11] funded by the European Union, was launched for elaborating socio-economic research in the Information Society. As a result, social research is defined as the collection, analysis or

interpretation of economic data, or data which relate to human behaviour, opinions, living or working conditions, or social institutions [4], [8]. Hence, it includes systematically gathering, analysing, and interpreting all this data with respect to the behaviour, knowledge, beliefs, attitudes, and values of human populations [5].

Consequently, the social research can be seen as the overall study of domain data that is processed by utilising a specific methodology for achieving the domain user needs. Furthermore, importance is attached to pointing out effects on other fields. By tailoring the socio-economic definition described to the AMIRA context, a specific methodology is produced for making a socio-economic study, which fits to the AMIRA requirements, and which is presented in the following section.

3.1   AMIRA FOCUS

The AMIRA goal of the socio-economic study of user needs is to analyse the potential usage and exploitation of the AMIRA technologies with respect to the targeted end-users of fire services and vehicle roadside assistance. The AMIRA project also has an objective concerning the development of Computer Support for Cooperative Work (CSCW) within mobile worker domains. This means support to enable mobile workers to get information for making diagnosis and decisions in time and business-critical situations. To achieve this, it is necessary to analyse in advance what the actual needs of end-users are, what they use today, what they could realistically use tomorrow in order to design a CSCW for meeting user requirements. In accordance with human behaviour, user opinions, and working conditions three points are figured out in the AMIRA context that have to be taken into account to reach the socio-economic goal:

- Analysis of the current state of working practices
- Elicitation of user requirements
- Development of use cases

First, an analysis of the current state of working practices in the fire services and vehicle roadside assistance domains provides information about how the mobile workers work today, which information sources or communication devices exist at work, and which sources or devices they really utilise in practise. This current state of working builds the foundations for all subsequent interpretations and results.

The second requirement concerns the elicitation of user requirements. In collaboration with end-users it is clarified whether demands on information support exist, or if existing information support has to be more efficiently integrated into their working procedures. Furthermore, suggestions for improvements on working procedures can be analysed together with the end-users. This can mean more efficient communication methods, access methods or information exchange within the domains.

Third, based on the current state of working practices and the user requirements, use cases of the AMIRA system can be determined that give an understanding of the way users interact and shows the functional application or the system. Use cases are not located on a technical level; rather they illustrate the interactions between the AMIRA system and the end-users on a highly abstract level. For a better understanding each use case can be emphasised by one or more scenarios that give explicit examples of realistic working procedures during operations.

Besides these three points, the acceptance by the end-users is crucial for the socio-economic study. For gaining user's acceptance the presented socio-economic study is developed in close collaboration with end-users in order to ensure that the planned library of reusable components can provide applications that are really wanted by the end users rather than simply developing technology for technologies' sake.

3.2   PURPOSES OF SOCIO-ECONOMIC STUDY

The purpose of this study is two-fold. First to provide the guidelines for the development of the AMIRA system, ensuring that it addresses user requirements and meets their needs. Secondly, to provide the end users with useful and validated information concerning their current working practices, potential ways to improve those practices and supporting tools and processes. To achieve this, the study uses four techniques - utility, relevance, originality, and industrial interests. Utility considers the applicability and the usage intended by the end-users. In general, the utility is taken as a kind of measurement in order to assess the profit gained from a product or service. In the scope of AMIRA, the utility is put on a level with the user acceptance. Relevance deals with questions on whether the product or service will benefit the society with respect to current societal needs. This includes the position in the state-of-the-art compared with other similar projects. Originality concerns the innovativeness of the focused product or service. Finally, industrial interests are taken into account during the development of the AMIRA system. For example, industrial interests can be the demand for new products or services. Furthermore, organisational research is addressed, including research related to business organisation or processes; the evaluation of internal processes are reviewed for their implication in enabling time-saving improvements with respect to the users' needs.

4   METHODOLOGY

Following the AMIRA focus the methodology for the socio-economic study is designed for analysing and combining primary and secondary data for surveying the end-user domains. In particular, the emphasis is put on the elicitation of user requirement and use cases. Consequently, the methodology consists of four different analysis levels:

1. Knowledge base interrogation and analyses;
2. Interviews and questionnaires;
3. Requirement assessment;
4. Evaluation;

Enabling an overall view of the user needs elicited from the domains as the levels include investigation of existing documents, interactive communication with end-users, and a review processes in collaboration with domain experts.

Besides the concentration on these levels the study focuses on coping with scientific standards of socio-economic studies that can be measured by specified success criteria. The aim is to verify these criteria in order to assess the success of the study.   To provide a closer view on the single analysis levels and the success criteria, the following sections describe the methodology in more detail.

4.1   KNOWLEDGE BASE INTERROGATION AND ANALYSIS

The first analysis level concerns the analysis of the contents of existing knowledge bases or documents, as well as taking into account other works on socio-economics undertaken in the same domains. The existing documents lead to conclusions about the current state of working that is one topic of the AMIRA focus. Additionally, it is used to produce a list of all available information sources and to list end-user skills that are crucial to the domains.

The current state of working denotes the way of working within the corresponding domain. This means the identification of typical processes that occur frequently. In association with the identified processes, scenarios can be formulated for representing the relation to the domain. Thus, situations during operations clarify the human behaviour, particularly at daily work, and potential teamwork activities to be supported by the AMIRA system. In order to understand the current state of working, it is useful to analyse documents that contain work instructions or descriptions of the end-users' work. The study focuses on all kinds of available documents that give information about

the way of working. Hence, the analysis enables the creation of a sketch of working procedures and an understanding of the way of working. The aim is to discover deficiencies within working procedures that can be improved or alleviated by appropriate information support. Tailored to the elicited deficiencies, requirements can be derived that build the basis for further socio-economic investigations.

To extend the current state of working, a list of information sources is extracted from knowledge bases to provide an understanding of the information support in the domains and enabling derivations of possible information access methods before, during or after incidents. Of further interest is how content is treated in the documents, enabling us to draw conclusions and to develop typical scenarios that describe how to support end-users.

To complete the current state of working and the information sources to provide a comprehensive view on the domains, end-user skills are uncovered and specified. Skills depend on end-users and describe their individual qualifications. Uncovering skills leads to new approaches about improvements of working practices and procedures and opens new facilities of information support during practising.

4.2 INTERVIEWS AND QUESTIONNAIRES

The second analysis level comprises both the review of the first level results and the elicitation of new knowledge about the domains. The first point facilitates finding replies on questions arising in the previous analysis. Interviews also enable the validation and confirmation of the previously elicited results. The second point refers to the elicitation of new data, e.g. tacit knowledge that does not currently exist in databases. Comparable to the first level, the objectives of this analysis level are to elaborate the current state of working, the information sources used, and the skills of end-users.

By providing a brief overview about the current state of working, the first analysis level establishes a basis for structuring a questionnaire that can act as a guideline throughout interviews. In order to develop this questionnaire, existing domain knowledge flows into this development process for tailoring the interview structure to facilitate the elicitation of user needs.

In this context, the aim of interviews or questionnaires is to have a closer look at the end-users side and to consider their opinion about their own working practices/procedures. The expected results of the interviews are to gather ideas about improvements of work practices/procedures to improve their efficiency. In particular, interviews provide conversation including interactions that leads to a better understanding on behalf of the interviewer, allowing them to request additional details for clarification. Furthermore, deficiencies in working procedures can be discovered in collaboration with the domain experts.

Finally, Information and Communication Technology (ICT) skills, social skills, and job-specific skills are important need to be set in a context and for elaborating its impacts on developing the AMIRA system.

4.3 REQUIREMENT ASSESSMENT

This analysis level represents the conclusions drawn from the previous levels. Of course, in the first two levels results have already been achieved but they are likely to change following subsequent analysis. After executing interviews and interrogating knowledge bases, working processes are identified that frequently occur in the fire service domain and that can be taken as representative processes for elaborating scenarios. These processes give information about the current state of working as well as enabling situations for integrating information support and collaborative working support. According to these processes integration options of the AMIRA system can be elaborated.

Predominantly, user needs are elicited, formulated, defined, and assessed based on the first and second analysis levels. These activities are comprised by the notion of requirement assessment

that indicates information gathering from the end-user domains and the interpretation of this information in order to derive user needs with respect to collaboratively working among users.

The analysis of the user needs encompasses the development of both the user requirements and the use cases. The notion of user requirements denotes a collection of requirements that describes characteristics about the required AMIRA system from the non-technical point of view. These characteristics are extracted from users' statements. Use cases are common to be integrated in a software development process and make clear interactions between the system and end-users. For an easier understanding, use cases are formulated without utilising technical terminology. Further, they are based on working procedures that frequently occur and describe processes related to how end-users can utilise the envisaged system. Associated to one process, more than one scenario can exist and clarify the application.

The structure of the requirement assessment consists of the extraction of user requirements, the derivation of use cases, and the verification of the use cases with respect to realistic scenarios. As a result of the requirement assessment, user requirements are specified in a list. The representations of the use cases encompass a textual explanation of the use case, an appropriate graphical illustration, and corresponding scenarios that occur in the domains. Concerning the graphical illustration the *Unified Modelling Language* (UML) is used because it provides methods for specifying, visualising, and documenting artefacts during software engineering processes and developments. Use cases can be located on the first level of such processes.

Beyond the elaboration of the user requirements and the use cases the skills of the domain end-users are elicited for completing the requirement assessment. Therewith, the focus is put on the individuals who do their job and who bring their experiences and personal knowledge into their daily work. Beyond pointing out the individual skills the aim is to describe working procedures from the comprehensive point of view and to develop suggestions for improvements.

4.4 EVALUATION

As the fourth analysis level, evaluation acts as a verification and validity check of the user needs drawn from the previous analyses. Predominantly, to ensure a high quality, the evaluation is done by domain experts. Referring to this, some evaluation criteria are taken into account for being validated on the evaluation level:

- Usability
- Applicability
- Relevance

Usability is an indicator of how easily the product or service can be used; it addresses the full spectrum of impacts upon user success and satisfaction. The anticipated user needs that are user-centred or user-driven are revised in relation to the user success and satisfaction.

Applicability refers to the envisaged system in action. Here, possibilities are discussed that concern situations in which the application of the system is realistic and practicable in the domains.

One key factor within the evaluation is relevance, which indicates how relevant the envisaged system is for end-users. The support of the system is discussed with respect to the quality and necessity. Expected improvement of working procedures uncovered by sophisticated persons estimates the relevance of the user needs.

Here, different perspectives are taken into account. First, the end-user domain experts have to be involved in the evaluation. The elicited user needs are revised by domain experts in relation to the evaluation criteria. This can be made by representing realistic scenarios or expert-driven explanation and argumentations. Experts are able to assess user needs based on their expert knowledge. Secondly, from the technological point of view, limits and advantages of applied technologies have to be considered by the AMIRA technology providers. For example, technology-driven limitations and extensions are taken into account. Finally, interdependences between user requirements and technologies are a crucial point for designing the overall technological solution

for supporting the domains. By combining the user and technology aspects requirements can be optimised for the overall AMIRA system.

4.5 SUCCESS CRITERIA

The study purposes identified in Section 3.2 are defined as success criteria that then act as a kind of assessment of the socio-economic study itself. These criteria have to be discussed with respect to the results of the socio-economic study in order to give information about the achievements. The following criteria are developed:

- Utility
- Relevance
- Originality
- Industrial Interests

Utility acts as indicator of the acceptance on behalf of the end-users how sufficient by content they are with respect to the developed requirements.

Relevance of the socio-economic study denotes its topicality in and its benefit for the society to whom it is aimed. Further, an assessment is derived from how the study fits into the societal demands and fits into current events.

Originality associates points of discussion through addressing new services, innovativeness, and incomparability. Here, a technology-centred state-of-the-art analysis is significant.

Industrial interests can be discussed both on behalf of the user domains and on behalf of the technology partners within the AMIRA project. From the users' point of view improvements and benefits during their work procedures are taken into account. For the assessment of the industrial interests of the technology partners technological progress and achievements are discussed.

4.6 TIME TABLE OF THE SOCIO-ECONOMIC STUDY

In accordance with the methodology previously described the analysis levels are arranged in the timetable depictured in Figure 1.
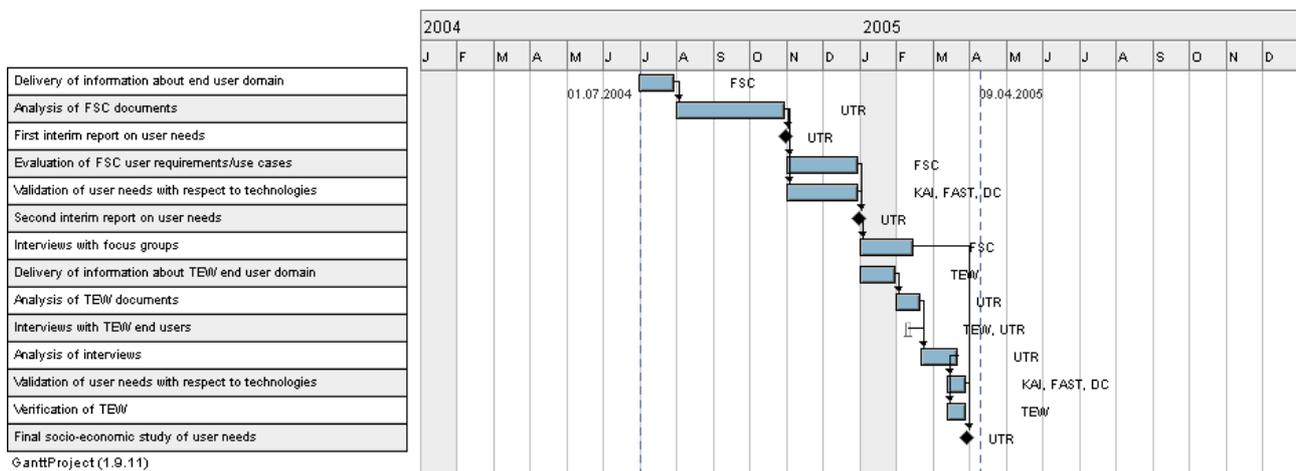
Figure 1: Time Table of the Socio-Economic Study

In the timetable, the socio-economic analysis procedures concerning two different domains become obvious. Firstly, the study is performed with respect to the fire service domain through *The Fire Service College* (FSC). After that the study of the *Transport Engineering Workshop* (TEW) domain is executed. Both studies are separately executed and the knowledge base interrogation and analysis, the interviews/questionnaire, the requirement assessment, and the evaluation level are assigned to the timetable.

5   FIRE SERVICE DOMAIN

The first domain the study deals with is the fire service domain. Here, the time-critical situations in fire emergency services are considered for specifying the requirements that build the basics for the AMIRA system. The study was undertaken in co-operation with the FSC, who provide the analysis with their expert knowledge, which includes a large amount of practice-based experiences.

5.1   KNOWLEDGE BASE INTERROGATION AND ANALYSIS

In this section the interrogation and analysis of the fire service domain is addressed. The fire service domain stands for the application domain for fire emergency services. These services are represented by the UK Fire Service College as domain experts. Fundamental to the presented study is the domain information delivered by fire services and the highly sophisticated knowledge provided by the FSC. In order to gain an understanding of these domain experts this section gives an introduction about the FSC and the way of working in the fire services itself. Furthermore, the knowledge bases, documents, and existing materials are presented and summarised as basis of the subsequent analysis.

5.1.1   Fire Service College

The Fire Service College (FSC) is UK governmental training and research establishment and is a legal entity registered as a 'UK Trading Agency' under the auspices of the Office of the Deputy Prime Minister. With 300 full-time staff, of which 100 are operational or retired fire-fighters, the FSC provides unique facilities for both practical and theoretical fire fighting, fire safety and accident emergency training. Established on the Moreton-in-Marsh site since 1968, the College has built its reputation as the premier fire related training establishment in the world, both in terms of the calibre and experience of its teaching staff and the scenarios it can offer. The College has residential and full catering facilities for 600 students. The FSC library is regarded as the most comprehensive fire, fire safety and emergency response related library in existence anywhere.

A wide variety of real-world incident scenarios can be realistically simulated on the FSC's extensive training ground. An endless variety of building fires and accidents can be staged and road, rail, aircraft and shipping together with chemical plant, oil storage, industrial and offshore emergencies are routinely recreated. Fire ground facilities include a chemical plant, ship, numerous aircraft, railway line and rolling stock, industrial and commercial buildings, road tankers and a motorway. The strictest standards of safety are maintained at all times.

The FSC offers courses to cover emergency response training for the entire processing industry on and offshore. Complemented by the recently installed management incident control suite, the College is able to offer the complete training solution for all personnel involved in emergency response management. Offshore training is offered to *Offshore Petroleum Industries Training Organisation* (OPITO), the *Norwegian Oil Industries Association* (OLF) and the *Maritime Safety Agency* (MSA) standards where appropriate. For onshore industries the FSC has developed emergency response standards on behalf of the Petroleum Industries National Training Organisation and run a number of courses to those standards.

The College has unrivalled expertise in fire safety and fire engineering. The *Prevention, Intervention, and Management Development* (PIMD) Division is at the forefront of fire safety training offering courses from foundation to degree level. Many of the division's tutors are seconded from United Kingdom Fire Brigades and are experienced in the practical application of the latest fire safety legislation and technology.

5.1.2   Roles and Hierarchies in the Fire Service Domain

The UK fire services are a hierarchically structured, disciplined organisation. It is undergoing a process of change from 'rank' based functionality, to one focussing on roles. The description of the most important roles enables a better understanding of the current state of working practices within

the fire service domain. The size of an incident determines which levels of command are involved in the incident.

The key figure at any incident is the incident commander (IC), who has responsibility for the overall command at any given time during the incident. Concerning management activities at large-scale incidents he/she is assisted by a command support team. At smaller incidents there may not be a dedicated command team available. In this case, the IC can nominate a junior officer or fire fighter to perform the role and tasks of command support.

At very large incidents the incident ground is divided in sections called sectors, each with its own commander. Sector commanders are responsible for the operations within their sector but they determine and respond to tactical objectives in close collaboration and coordination with the incident commander. If an incident is of a complex nature with several command areas it may be necessary for the incident command to appoint an additional layer of commander using an operations commander. His/her role is to assist the incident commander in coordinating, monitoring and supporting the sector commanders. The section commanders coordinate their crews, including fire fighters, in line with the requirement for the National Occupational Standards and the Incident Command System.

Additionally, more officers can assist the incident commander in maintaining, order by acting in supporting roles as functional commanders i.e. monitoring officer, safety officer, hazardous materials & environmental protection officer (HMEPO), marshalling officer, equipment officer, water officer, liaison officer.

5.1.3   Existing Knowledge Bases and Documents

This section gives information about existing knowledge bases and documents in the fire service domain. Due of the existence of 58 different fire authorities, comparable/identical documents are frequently denoted by different terms. In order to avoid confusion with terminology several terms have been agreed and are defined as follows:

The main knowledge bases can be denoted by the following terms:

- standard operating procedures (SOPs), brigade orders; control room notes; operational notes.

Beyond these documents a large amount of other notes are encountered that are not described in detail by the presented study.

The following descriptions of the operational notes, control room notes as well as the brigade orders are based upon the information from *London Fire Brigade* (LFB) [7]. These documents describe the way of working (SOP) within the fire services as well as providing hints how to practice procedures. They also provide an understanding about the current state of working practices at LFB. These kinds of notes vary between the 58 fire services, but in general every fire service has notes that cover the contents described in this section.

The Office of the Deputy Prime Minister (ODPM) has produced a generic management of risk document for brigades from which SOP's are produced.

Furthermore, different fire service studies already exist that describe and give reasons for requirements occurring in the domain. Also requirements concerning mobile information support are elicited by special organisations and whose results are published on the Internet.

5.1.3.1 Brigade Orders

Brigade orders (BOs) stipulate instructions for brigade members how to proceed at work. For documentation purposes these orders are written down in documents acting as manuals for consultation. BOs can contain treatments of orders or how to realise special actions. The available orders, authored in 1994, specify for example the mobilising of appliances to incidents. They describe in detail the content that the mobilising message has to contain, the way a message has to look, and the way a message can be sent. Otherwise, BOs specify responsibilities at incidents by hierarchically ordering operatives' roles and assigning responsibilities to roles.

Furthermore, it is possible that BOs reference operational notes by an identification number. Because of not being linked to the corresponding operational note it is very cumbersome to navigate through when working on these documents.

5.1.3.2 Control Room Notes

Control room notes (CRNs) structure activities in control rooms and specify operations of appliances depending on different conditions. The available CRNs were authored between 1993 and 1996. One CRN refers to one operation and gives a comprehensive and detailed description of it. The control room orders describe the activities on the control side, e.g. workflows are described how to deal with action forces, what to do when officers in charge leave the fire station, and how to deal with or to manage the *Central Risk Register* (CRR).

Control room notes consist of the following contents:

- Notifications to be done
- Contact data to organisations involved
- Procedure description of operations
- Further information
- Affected instructions

Concerning a special kind of operation a control room order contains instructions for notifying important organisations which are involved in the incident and which have to be informed when this kind of incident occurs. For that purpose, the contact data is captured as well for a fast acting on behalf of the control room.

The main purpose of the control room order is to describe the procedure, which occurs in operations. Generally, the procedure is presented in a textual and detailed way while other CRNs are referenced by the procedure description. Consequently, novices who do not know any CRN have to navigate through several notes for getting an overview what to do in the operation. By only using the text documents this represents a time-consuming task.

The section containing further information presents additional information sources like operational notes, brigade orders, further CRNs or other text files that could be important to know.

At least, instructions affected by the presented CRN are listed. For example, the presented CRN can overwrite other orders or they contain marks that say the CRN is not up-to-date anymore.

Furthermore, CRN can comprise information about equipment needed for the current operation, e.g. where can the equipment be obtained from and who has to be called in order to get the equipment in question.

5.1.3.3 Operational Notes

One *operational note* (ON) describes one incident operation by presenting all necessary information around it. In contrast to CRNs, the corresponding actions and instructions described by the ONs are executed by operational personnel such as fire fighters and fire officers. For example, operational notes exist about fire investigations, mobilising policy, operational pre-planning and information gathering.

The available ONs are authored between 1981 and 2000 and, usually, their structure consists of different sections; typical sections are:

- Introduction
- Operational consideration
- Identification
- Operational procedures
- Personal protection
- Training

- Communications

- Contingency planning

- Instructions affected

The introduction gives a brief overview about the subject and initial conditions within the corresponding fire service. After that, operational notes give comprehensive overviews about the incident. This can be conditions that have to be checked or important additional information that has impacts on further proceedings. Moreover, consequences on other fields are listed which should be taken into account for avoiding unintentional effects. For example, concerning railway procedures fire fighters and fire officers have to think carefully about stopping trains because it leads to long delays and substantial business loss. In that situation, the section about the operational consideration gives reasons for stopping trains.

The section identification concerns the process to identify situations whether the operational note can be applied or not. This encompasses also the specification of risk control measures that have to be taken into account always. For instance, risks are listed which can occur relating the described kind of incident and risk control measures are itemised that have to be considered when dealing with respect to the incident.

The core of ONs is the description of operation procedures that gives operating instructions in detail. Presented in a bullet list single activities of the procedure are listed in association to the executing persons and their roles. For example, the contents of operation procedures can be instructions for dynamic risk assessment, for information gathering, and for recording gathered information. These instructions include both methods for information access and information sources. Beyond the presentation of the bullet list the operational procedure is sometimes graphically pictured as shown by Figure 2 that illustrates flow plan including operating instructions.
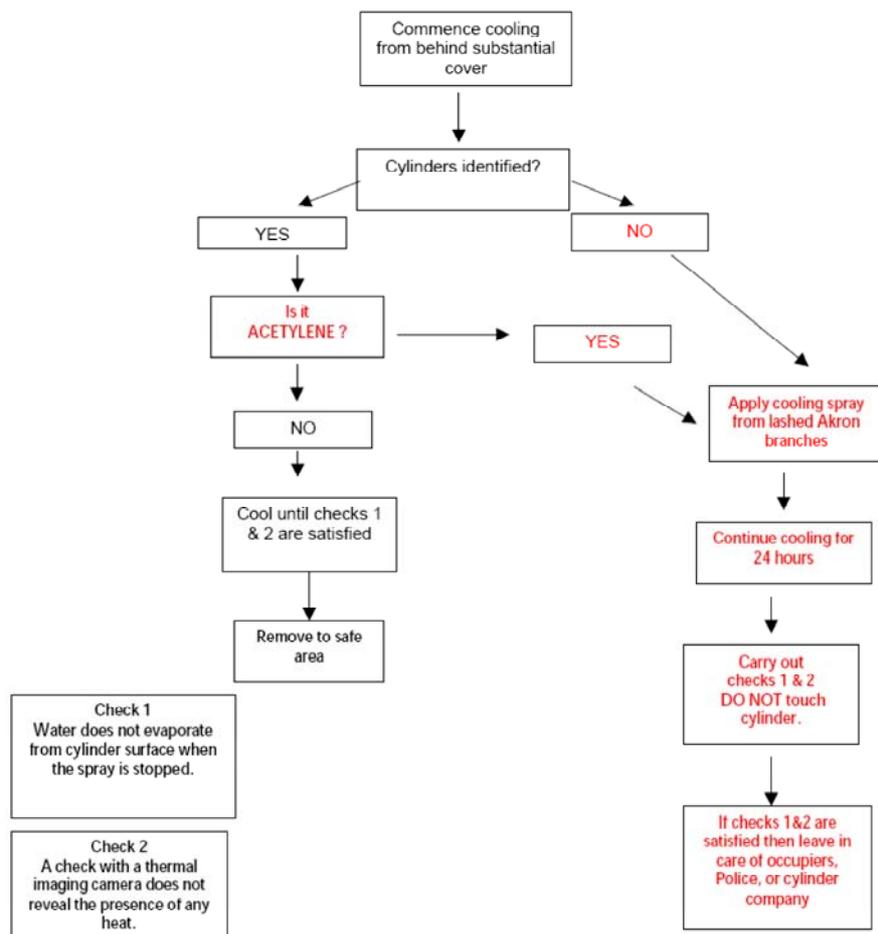
Figure 2: Example of Flow Charts captured by an ON

In contrast to the textual specification of the operating instructions, the flowcharts provide a clear and concise representation of instructions that gets to the point and obviously shows what to do next. Hence, such flowcharts can be utilised as guideline in action for getting support in proceeding further as well as additional information about what has to be considered. Comprehensive guidelines enable an overall view of incidents without allowing users to ignore facts and to neglect information that could be important in some situations. Consequently, instructions are contained that address checks for preconditions for further diagnoses and decisions.

ON060
Cylinders involved in fires or subjected to heat

When it is known or suspected that cylinders are involved, a priority message must be sent; **Cylinders Involved. Thermal Imaging Camera required.**

Site appliances upwind and clear of projectile hazards.

Send an informative message, as soon as possible, indicating the quantity and contents of cylinders.

Obtain CRR information.

Obtain any applicable information from the Operational Information Folder.

If cylinders are leaking?

Implement the provisions of ON 44

Set up restricted zone, minimum number of personnel inside the zone.

Consider the need to evacuate the immediate area. Request attendance of the Police to co-ordinate any evacuation.

Remove, or cover with spray/jets, cylinders not directly involved.

Start cooling the cylinders as quickly as possible with a spray jet using a minimum 12.5mm nozzle and 45mm hose line. Cooling should be conducted from behind substantial cover. Consider lashing branches in position. Take action to minimise water damage.

When all personnel are suitably rigged, send a message confirming: **Cylinder Procedure implemented.**

Personnel inside the zone to be rigged in full fire-fighting uniform with the firehood in the raised position, and BA. Safety crew to be similarly rigged.

Examples of adequate cover include; substantial brick, block or concrete walls. Furniture, timber fences and vehicles should not be considered as providing substantial cover.

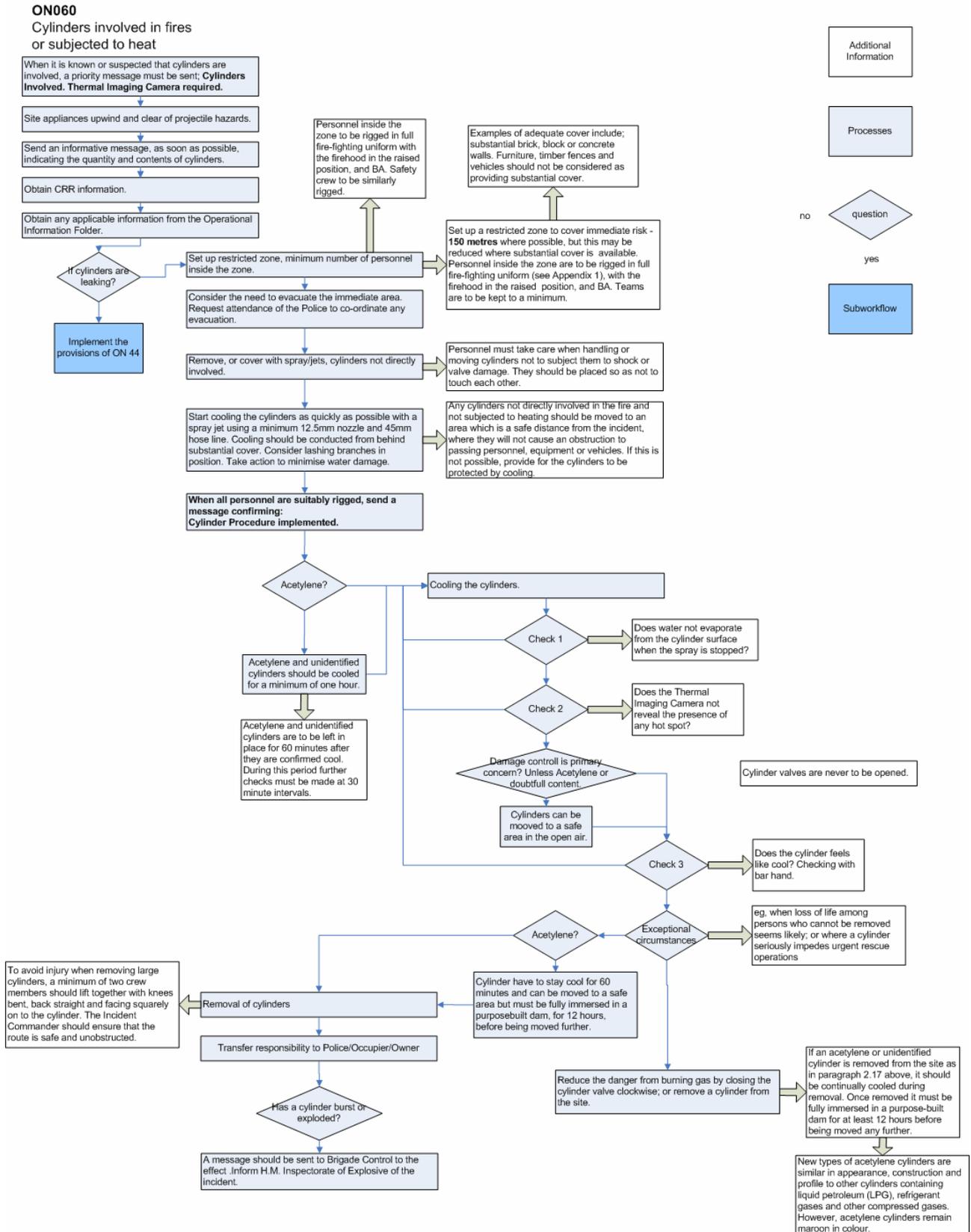Set up a restricted zone to cover immediate risk - **150 metres** where possible, but this may be reduced where substantial cover is available. Personnel inside the zone are to be rigged in full fire-fighting uniform (see Appendix 1), with the firehood in the raised position, and BA. Teams are to be kept to a minimum.

Personnel must take care when handling or moving cylinders not to subject them to shock or valve damage. They should be placed so as not to touch each other.

Any cylinders not directly involved in the fire and not subjected to heating should be moved to an area which is a safe distance from the incident, where they will not cause an obstruction to passing personnel, equipment or vehicles. If this is not possible, provide for the cylinders to be protected by cooling.

Acetylene?

Cooling the cylinders.

Acetylene and unidentified cylinders should be cooled for a minimum of one hour.

Acetylene and unidentified cylinders are to be left in place for 60 minutes after they are confirmed cool. During this period further checks must be made at 30 minute intervals.

Check 1

Does water not evaporate from the cylinder surface when the spray is stopped?

Check 2

Does the Thermal Imaging Camera not reveal the presence of any hot spot?

Damage controll is primary concern? Unless Acetylene or doubtfull content.

Cylinder valves are never to be opened.

Cylinders can be mooved to a safe area in the open air.

Check 3

Does the cylinder feels like cool? Checking with bar hand.

Acetylene?

Exceptional circumstances

eg, when loss of life among persons who cannot be removed seems likely; or where a cylinder seriously impedes urgent rescue operations

To avoid injury when removing large cylinders, a minimum of two crew members should lift together with knees bent, back straight and facing squarely on to the cylinder. The Incident Commander should ensure that the route is safe and unobstructed.

Removal of cylinders

Cylinder have to stay cool for 60 minutes and can be moved to a safe area but must be fully immersed in a purposebuilt dam, for 12 hours, before being moved further.

Transfer responsibility to Police/Occupier/Owner

Reduce the danger from burning gas by closing the cylinder valve clockwise; or remove a cylinder from the site.

If an acetylene or unidentified cylinder is removed from the site as in paragraph 2.17 above, it should be continually cooled during removal. Once removed it must be fully immersed in a purpose-built dam for at least 12 hours before being moved any further.

Has a cylinder burst or exploded?

A message should be sent to Brigade Control to the effect .Inform H.M. Inspectorate of Explosive of the incident.

New types of acetylene cylinders are similar in appearance, construction and profile to other cylinders containing liquid petroleum (LPG), refrigerant gases and other compressed gases. However, acetylene cylinders remain maroon in colour.

Additional Information

Processes

no   question   yes

Subworkflow

Figure 3: Comprehensive Flow Chart of an Operational Note

During operations personal protection is vitally important for the operatives. In life-critical situations the fire fighters involved have to protect themselves before acting on location. Therefore, operational notes contain instructions about what to wear within the restricted zone of incident.

Sometimes sections about training are included by ONs. The sections encompass instructions for Training Officers, including what they have to take into account when holding training sequences. In particular, advice related to life and time-critical situations' training is captured.

If necessary, options for communicating with other emergency personnel (police, civil defence, military, transport infrastructure personnel etc.) are listed by the ONs. This is important when working in unknown environments, e.g. railway infrastructures. Then, the means of communication during operations is explained.

Furthermore, operational notes capture information about contingency plans for critical situations that are described in detail as good as possible. Also architectural information about public buildings and infrastructures complement ONs; the section also lists all instructions notes that are no longer up-to-date.

For a better understanding, the comprehensive operational note of incidents when cylinders are involved in fires or subjected to heat is illustrated by a flow chart depicted in Figure 3. Here, the operational procedure is presented by the flowchart. For experienced persons the chart is sufficient but additional information is necessary for novices in order to get a comprehensive view on the incident procedure.

5.1.3.4 Other Documents

London Fire Brigade made available further documents in the scope of this socio-economic study. Therefore, documents about risk assessments and fire control plans concerning industrial fires are also accessible within the fire service domain.

It seems that every possible situation during a fire fighters' work is documented, annotated by useful information, and stored as a file. How to access these documents becomes not obvious on this level of analysis.

5.1.3.5 CFOA Mobile Data Study

The *Chief Fire Officers Association* (CFOA) commissioned a study to determine the necessary data required by fire fighters or mobile officers and access methods. The main study report, called The CFOA Mobile Data Study [1] was published in 2001. The vision of this study was that "relevant, accurate, timely information should be available to all staff at any location from a single source as an integral part of the working environment" [1].

This study was based on another Mobile Data Scoping study undertaken by Smith Industries Ltd in 1993. At that time the study concluded the need for a common standard of mobile data systems within the fire service domain. A standard MS-Office application operating in a Windows environment is not considered appropriate in a mobile environment. One crucial issue is the conclusion that often the data to be transmitted is too large for reliable over air-transmission that means restrictions for the mobile data support.

Within the CFOA study mobile data systems are defined as systems that are permanently fixed in vehicles, temporarily fixed via docking port, as well as portable equipment such as handheld computers and personal data assistants (PDA's). Investigations of the study made obvious that the different fire services have different software and hardware to support their operatives, which often do not interact with other fire service systems. Based on this information, and that no standard methodology exists in fire services for mobile data support, the CFOA group focused on the appropriateness of legacy systems, the costs and means of assembling data, the hardware and software required to manage the data, and the IT strategy that should be implemented to support the development of mobile data. Motivated by the need to improve health and safety and by reducing radio traffics, the initiative of CFOA was to suggest a common standard for mobile data support that would enable a larger and more cost effective procurement strategy.

By executing interviews and questionnaires the CFOA mobile data group's purpose was pointing out the mobile data systems required, the main drivers, and past experiences (lessons learnt). Therefore, from a more technical point of view the study itemised both software and hardware requirements. For example, the software requirements are listed including industry standards and

provision of printing facilities. Also requirements specify the hardware, e.g. its ruggedness and its design.

Furthermore, the CFOA group envisage a common protocol based on XML Schema for data exchange and development activities are leveraged by the group. Acting as interpreter or bridge XML Schema should mediate between disparate software systems. This technique should be the solution in order to share data and to use a common database. The study concludes that fire services are generally reluctant in accepting new systems because of populated legacy systems, usual design forms, and habits special to a single fire service. Because of supporting legacy and preferred systems a common format or protocol is leveraged for increasing acceptance on behalf of the fire services. Consequently, a document management system based on standardised formats and protocols enables working with the proprietary documents of individual fire services and a reduction in the number of systems in use.

The CFOA group worked out aspects that would have an impact on developing appropriate document management systems. Concerning this the impact of data sharing, data exchange, and data update methods were taken into account for realising interoperability between fire services and assuring the reliability of data. In the scope of the study the role of the radio is a crucial point for status updates and text messaging. Hence, developments concerning radio facilities are focused.

In summary, three main results were concluded from the CFOA Mobile Data Study [1]:

- Current installed systems are predominantly stand-alone, not connected to control headquarters or other departments. These systems provide basic essential data, e.g. operational procedures, hazard information, and are separated from the radio connectivity.

- Current installed systems provide different access methods and different forms of representing results.

- The system's update audit trail is critical. Whatever methods brigades adopt to update mobile data systems, there must be an effective validation procedure in place.

By summarising the results of the CFOA Mobile Data Study a list of requirements becomes obvious that have to be considered when designing mobile data systems for supporting fire services. Therefore, all eventualities are examined for itemising needs on both the operatives' side as well as the control room side. Requirements drawn from the conclusions mainly relate to focusing on accuracy and reliability, to producing risk-related information, to support interoperability, and to provide data sharing.

5.1.4 RIMSAT Project

The RIMSAT (Remote Intelligence Management Support and Training) project [11] was funded by the European Commission and "designed to provide an innovative, 'intelligent', knowledge based solution aimed at improving the quality of critical decisions and to enhance the competencies and responsiveness of individuals and organisations involved in highly complex, safety critical incidents – irrespective of their location".

Comparable to the AMIRA project the RIMSAT project focused on the same application domain, the fire services, incorporating aspects of safety-critical incidents but the technological purposes were very different. Within the RIMSAT project the consortium developed an integrated *Case-Based Reasoning* (CBR) and *Model-Based Reasoning* (MBR) decision support system to deliver knowledge [6]. By combining CBR and MBR this project focuses on the provision of case-based and model-based recommendations associated to models observed in the domain. Instead of depending on such models the AMIRA goals are the provision of information in fast changing environments and the support of collaborative working in time- and business-critical situations. A further difference of AMIRA is the integration of the facility of speech-based requests for supporting mobile and remote access to the envisaged system.

Nevertheless, the RIMSAT consortium executed an analysis of current user practices within the fire service domain that is partially overlapping with the presented study. Here, the main results are briefly described:

- After analysing two fire service examples of use, fires involving industrial premises and transportation incident involving hazardous materials, the demand for a decision support system was concluded.

- The envisaged system had to meet the following requirements: to capture data and information, to retrieve the captured data and information, to be applied in a hostile and dynamic environment, to provide individual users, to provide a learning environment.

- Fundamental to the RIMSAT objectives was to address as far as possible the ideals posed by the fire services in their Wish List shown in Annex 1.

5.2 INTERVIEWS AND QUESTIONNAIRES

During the development of the AMIRA interview and questionnaire structures different questions were encountered that referred to the current state of working, to the information sources, and to the individual skills of end-user that could not be answered up to this point of the socio-economic study. Otherwise, during the developments of the questionnaire analogies were uncovered that refer to interviews already done within the RIMSAT project. Because of sharing the same application domain, the RIMSAT project also comprised a Workpackage that concerns a study about the user needs. Within that Workpackage interviews were executed that also fit to the intention of the AMIRA study but in RIMSAT another focus was taken into account, namely chemical incidents. However, as primary source the RIMSAT transcripts capture original data of the interviews that enable the elicitation of user needs independent of the results of the RIMSAT project. The transcripts give answers to concluded questions uncovered during analysis of existing documents and are very informative with respect to current state of working, user requirements, and use cases that can be elicited referring the single fire brigade station. Thus, a respective summary will describe the situation on location.

Furthermore, the analysis of these interviews gives an overview about how the brigades work and which information sources are used without going into details of their focus. Further details were uncovered concerning the need of how to support young inexperienced incident commanders, which is addressed by the AMIRA project. Young, inexperienced officers are put in charge of crews and incidents. They are required to make dynamic decisions in safety-critical high risk environments, utilising a range of skills in a time-critical manner. The major aim of the FSC in AMIRA is the support of these young inexperienced officers. Therefore, additional knowledge will be acquired through focus group sessions as described in this section.

5.2.1 Interview Transcripts

The transcripts are executed by using an interview guideline, which specifies the interview structure. With regard to content the interviews consists of the following sections:

- Formalities
- Primary sources of knowledge/information
- Beginning of incidents
- On route
- Arrival
- Command until handover
- Handover
- Review

The purpose is to describe the incident stages by focusing on HAZMAT (Hazardous Material) incidents that deal with the transportation of hazardous materials and industrial incidents, which comprise industrial premises. Such incidents represent both frequent situations within the fire services and contrary examples, because industrial fire incidents are time-critical to be stopped

before getting out of control and hazardous material incidents require analysis-driven activities in order to stop incidents escalating.

Throughout the interviews the transmission of information at an incident is described from different points of view, depending on when an officer arrives at the incident. They can arrive at first or they can arrive later for taking over the command. For a better understanding the first interview is described in detail; the further descriptions focus on the differences and new information given by the interview participants.

5.2.1.1 Hampshire Fire Brigade

Within Hampshire Fire and Rescue Services [2] three sessions are executed with people holding different kinds of appointments within the fire service. The first session involved a command strategy officer, senior trainer, senior divisional officer, divisional officer, and contingency planning officer. Retained officers, e.g. sub officers, leading fire fighters or leading firemen, took part in the second session. Finally, the third session targeted first response officers, such as   sub officers, leading firemen, leading fire fighters, and watch commander.

All involved persons had been working in the fire services for many years. Consequently, they had a large amount of information based on their experiences, which makes their statements reliable and significant. Moreover, they can give a view on the history of changes within fire services, particularly with respect to information exchanges.

5.2.1.1.1 Primary Sources of Knowledge/Information

The Hampshire fire service utilises several sources of knowledge. In this context, the officers differ between local knowledge and several knowledge bases. Local knowledge denotes the knowledge that officers and persons involved bring into the incident and that concerns to the local environment or premises. Naturally, they have gained the local knowledge off their job personally because of working or having worked in industrial buildings etc.

The most important information source is the set of service orders that act as guidelines for incidents. The quality, accuracy, and relevance are superb but the large amount of information can be interpreted as disadvantage based on interview statements. Further, some service orders are very good sources but some have not been updated since 1974. Service orders are only captured in books and as text documents in the Intranet to which just stations and certain post holders can access. The service orders are carried by each pump and each flexible duty officer, so that the knowledge base is local-independent. The base is applied in incidents out of the ordinary and the users take the contained information for accurate and very useful in practise. The maintenance procedures of the knowledge base made by the department are very strict when modifications, updates, or new entries have to be made. Due to the utilisation of a large amount of volumes each single volume has to be updated.

A short form of service orders are the Fire Facts; a bullet list that give accounts of the service orders. The idea is that there is a Fire Fact for every operation service order, which describes how to deal with a special kind of incident. The Fire Facts comprise both functional roles and standard operational procedures that give information about actions prompts, i.e. what action has to be executed next.

Before coming to incidents, operatives can view operational plans for further procedures but they are only available for large buildings like warehouses and factories. Operational plans come from the divisional operation department and are managed by the headquarters. Furthermore, these plans are carried by the relevant pumps, so everyone involved in the imminent incident have access to operational plans. Operational plans consist of information about premises and its properties. According to the interviewed officers some operational plans are only reviewed every three years but most plans are reviewed every year. Hence, it is not sure whether the operational plans are reliable or not. For updating this information it is necessary to speak with the occupier, the owner or user of the premises. In general, the fire fighters find out more information at the end of the operation. In addition, experiences made by the crews supplement the available knowledge

sources. The review processes of the operational plans are up to the station personnel and are overlooked by the Divisional Operational Department.

Further detailed information about the premises is contained by the Premises Inspection (PI) cards also called risk assessment card. Being centrally kept, these cards are annually reviewed and circulate to all of the station. Review processes means to go out to the premises for re-inspecting. When determining a risk change at the building reviewers are able to amend it and to capture it into the database. In general, PI cards are only available for high-risk buildings; 90% of the industrial buildings have no risk assessment card.

At some premises, the fire services can get private documents about the premises and about all-important stuff needed so that they know where to go. The reliability of the documents obtained on location normally depends on the size of the company or premises. For instance, big companies keep their own premise inspections up-to-date; in contrast small garages do not have any plans or PIs. Consequently, people staying on location are interviewed for useful information about storages or existing hazardous things.

Data sources are available that contain relevant phone numbers, information about poisons etc. For instance, the SAX, a chemical industry database book, is available for searching for information on poisons. Fire officers have access to systems via laptop computers to obtain information related to hazardous materials (HAZMET), or chemical information supplied through the ChemData database and by the Cirrus CD-Rom.

Full-time officers who are qualified can be appointed as a Hazardous Materials & Environmental Protection (HEMP) Officer. They are responsible for the retrieval of necessary information and for passing it on to the other officers involved, in particular to support the tactical decisions made by the incident commander. There are a number of forms of either paper-based or information sources that the HEMP officer can interpret to aid the decisions and actions of the incident commander. One such information source is called a TREM Card, which must be carried by hauliers of dangerous materials. A TREM Card contains information that may assist decisions to manage HMEP incidents. More information about emergency action codes, information for all sorts of substances, contact numbers, and specialist contact numbers are covered. This information is also available at the *Special Equipment Unit* (SEU) specially designed for HMEP operations. On the SEU there is a special computerised system, which enables the recording of information phonetically spelt by the crew. Also phonetically spelt requests can be directly sent to control if no suitable information is available at the location and should be done to record the information sources against the decision making skills of the incident commander.

In addition, laptops are used to get the same information that is available in control rooms. However not every officer has got a laptop. Using laptops, Area Managers and above are able to access a command and control system called *Fire Cat*. This system enables officers to get an overview off resources throughout the brigade and to get information from the fire ground as control operators. Descriptions can be viewed from incidents that are still in progress and that has happened in the last 12 months. Some officers have the laptop on all day because they are interesting in but they do not have to. Often, the system is used to see what has happened the day or night before.

Additionally, different telephone numbers are available for getting information. For example, the number of the National Poisons Unit at Guy's Hospital in London, or the number of the CHEMET system that responds to a call for providing a fax of a good quality weather map.

Other information sources are available on the appliances. For example, books of large scale maps in order to find the best route to the incident. In addition, fax machines are installed on the appliances enabling hardcopies to be made of requested information sent by the control room or other institutions.

Future plans are to fit out every participating officer with mobile data transmission where they can get information from control. *Mobile Data Terminals* (MDT) are available now but not for everyone, just a few officers have access to MDT's. On the one hand, the MDT can be seen as communication systems for requesting and getting answers from someone at the control room,

and responses can be printed as a hardcopy by the printer that is available in the pump's cab. On the other hand, MDTs include emergency action codes, first aid information, environment information, fire instructions. Also PI cards and operational plans can be put on the MDT. Though the MDT can be accepted as expert and the quality is good, it is not in use very often because of presenting an overflow of information, which the user has to filter for the bit he/she wants. But there are other opinions as well that say information received from the MDT is not reliable and that they prefer to rely on a radio. The reason is that the technique of the MDT is not up-to-date but 10 years behind.

Part of the requirements of the *Incident Command System* (ICS) is organisation of the incident ground. Recording of all information either presented or relayed to the incident commander, and the decisions he/she made are kept as a written log for both audit purposes and as debrief for review of the operational procedures. This information is collected using notebooks or purpose made forms. Hence, all information can be collected and stored together at a command unit. However, the fire crews are informed only by word-of-mouth.

Pagers and teleprinters act as information sources at the beginning of an incident for notifying the fire fighters, crew managers and officers of the incident type. Call sheets are available at the fire station; these sheets encompass all information known about the incident. Further information if required can be sought by access via Intranet that acts as knowledge base. For instance, the brigade Intranet provides information about risk assessment for particular activities including suggested control measures and proposed primary action requirements of crews.

Beyond the information sources used during incident, training activities are also incorporated into the officers' role. In general, every 2 years officers receive a training day to develop various scenarios and to gain further competences. Those personnel chosen to act as HEMP officers attend a specially designed course to gain competences in dealing with HEMP incidents. Usually this is done at the FSC. Further training is delivered either in brigade of on a 1-week refresher at the FSC or similar establishment. Secondly, the Training *Assessment Plans and Programmes System* (TAPPS) is integrated into the actual knowledge support system. At present, TAPPS is a system for officers, which provides different knowledge levels for training activities, especially for command and control training as well as HMEP training.

5.2.1.1.2 Information Support in the Beginning of Incidents

At the beginning of an incident, crews get a radio message or teleprinter message that consists of an address, a map reference, the type of incident, the role (of the fire crew), and the location. Depending on the type of incident, an experienced officer may be required to attend. If this is necessary he/she will be either paged or telephoned and mobilised to the incident. They confirm the details with the control room by radio. Depending on the incident further information can be received by radio or pager. Sometimes the control room rings the officer and informs him/her of operational events at the incident. For getting to the incidents officers can utilise the map books or they can be guided by the control room if the route is too difficult.

In contrast, retained crews are alerted by pagers that are only able to beep. They get the call sheet at the station with the most important information like address, map reference, hydrants location, incident number, time of call, PI information, and appliances that are going. In particular, PI cards can be printed in the appliances that often takes a lot of time during incident because the result sheets are often about three feet long. This means they are hard to manage.

5.2.1.1.3 On Route

In order to gain information about the incident whilst on route to the call, officers, when mobilised, will listen to the radio and wait for informative messages detailing what is happening at the incident. They can interact with the incident crews by calling the control room and make comments and suggestions in support of the officers at the incident ground. Thereupon, the control room can pass on the information or request to the crews and incident commander at the incidents.

The listening officers are not able to directly contact the men in the field for questioning purposes. Dialogue communication is only possible to the control room and the *Operational Equipment Technician* (OET). Sometimes the OET is used for getting an update what is going on in the field.

5.2.1.1.4 Arrival

On arrival, the officers put their fire kit on and book their attendance whilst capturing as much information as possible about the incident. Which information sources are available depends on the point of arrival time. The officer who arrives first has to view the incident to get information about the incident, operations employed at that point to aid them making tactical decisions. This means walking around the incident and assessing the activities being carried out, as well understanding the requirements of the incident. Gathering good, accurate and timely information at the incident is paramount. For instance, signs of information that could influence his/her decision could be the colour of the smoke, any other flames, and the sources of the flames. Witnesses are another information source but sometimes it is a challenge for eliciting information from witnesses because they do not put the information in concrete terms.

For officers arriving later on the scene, information has already been reported by the officer in charge and he can again give a first assessment of the current situation to newcomers. Usually, the order of activities after arrival is not fixed. In general, it is assumed that experienced officers keep calm and look around for vital incident information before going to the control/command point for confirming their attendance. Having a look around the recently arrived officer can take stock of measures that have already been put in place - i.e. the scale and the scope of the incident, whether it's likely to progress, whether there are enough resources, scale of potential fire, and obvious hazards. Based on experience, when stepping back a bit, officers can frequently gather more information than the officers who are already involved in the incident. In a nutshell, experience is the most important information source.

Information that is missing or difficult to access relates to the construction of buildings and about resources necessary for this type of construction. Often, the officer can assess the circumstances based on their experiences. But for novices it is hard to balance the first impressions.

After assessing the situation, it is unusual to look at the Fire Facts books (if the authority issues them). If there is something to look up, they will look at Fire Facts as a source of reference before they get their kit on. Occasionally, there are some officers who take the Fire Fact sheet with them.

In contrast with full-time officers retained service officers benefit from their practical actual jobs. For instance, because the may work in similar industrial buildings the retained officer can bring their experiences into their work as fire fighter. Concurrently, they can take their local knowledge based on experiences into the crews for knowledge sharing. Sometimes the local knowledge is of more benefit than PI cards or operational plans. However, it must be noted that SOP's should still be followed.

5.2.1.1.5 Command until Handover

Throughout the command period until handover the same information sources are available as at the arrival stage. During this time the fire fighters are expected to get control of the fire or over the hazardous materials. Therefore, they need much support in analysing and revealing unknown materials or in decision support how to extinguish the fire in the time-critical situation.

At most incidents, retained services arrive first and, if necessary, full-time officers will subsequently take over because of their additional competencies. Up to handover, retained officers collate available information and make decisions on this information.

It is the decision of the arriving officer if he takes over or not. A reason for not taking over is when the action plan of the first officer in charge is compliant to the action plan of the arriving officer. Then, there is no need to take over. Against it, if it is obvious that the first officer in charge lacks important information or does not feel comfortable with the current situation, then a handover is made after information is exchanged. At large-scale incidents that have been running for some time command folders are applied for storing information. Basically the command folder is a wallet

- a sort of A3-size fold out wallet, that contains short information about resources on the scene, any control measures that should be adopted, whether a risk assessment has been done etc. Probably this information is obtained from the occupier of the premises, the owner of the premises or from observations. The incident command wallet is carried by the frontline appliances which basically gives the incident commander prompt sheets on what to do. Furthermore, officers are able to record risk assessment on it.

The handover/takeover information is not recorded by control room; just a message goes to control room to update that there is now a change of incident commander.

5.2.1.1.6 Handover

In handing over the first officer in charge gives the subsequent officer all the important information gathered/identified during the first phase. This can be information about personnel, the whole scenario, what was done, and what needs to be done.

Depending on the incident's size and on whether the information log is filled out or the Incident Command Unit is full of information, the information at handover is either in verbal or in written form. To achieve a smooth handover at complex incidents, relief officers should write down all necessary information. In addition, ICS is taken as knowledge base or relief officers brief the following officer about what to do next and about what they are expected to do with respect to previous observations.

For very important messages it is possible to log it in a message sent to the control room because it is a reliable log. In practice, if you make a handover to a well known officer or to officers who have been with you throughout the incident then there is no need to write anything down for him/her. But for unknown people, i.e. police occupier, it is important to log the information. In particular, it is important to log all information when the fire service is leaving all together. Then, a formal hand over is made to ensure that everything is recorded.

5.2.1.1.7 Review

After leaving an incident there are different procedures or post debriefs for review that depends on the number of pumps (Fire appliances). The formalised debriefs are for capturing what has happened at that incident and are sent round to all the crews and to all persons involved. After incorporating all the comments it is then turned into a final report that is published in the Intranet in the scope of the routine notices. Routine notices have an Operational Bulletin attached, which describes the relevant points that came out of the overall incident scenario. To create a formal report everyone has to get together, again they are asked to provide information. Consequently, the formal report collaboratively developed is added to the Intranet resources that are available for everyone. One computer is located at each station and officers can login from personal computer at their homes. Based on experiences the Intranet is not much in use.

In the Hampshire Fire Service and Rescue Station lessons learnt are integrated. Newly gained knowledge is used to inform other colleagues about recently incidents. After the incident where particular things are learnt the involved persons come back to the station, re-set the scenario, and let the non-involved crews go through the incident. They can discuss the scenario what to do on location and they get to know the information learnt by the involved officers. Consequently, the lessons learnt are passed on but just within the stations.

Furthermore, after large-scale incidents written debriefs are sent to the stations involved for capturing information about the incidents and locations. The written debriefs only address the officer in charge who talks again to the officers on the pump for getting more information to fill in. Because of being located in the station rooms the written debriefs can be accessed by the officers whenever they can spend time for it. But for the retained presence it is very hard to spend time on reading the formal debriefs because of their prime jobs.

5.2.1.1.8 Conclusion

For illustrating the large amount of different information sources Figure 4 shows the collated sources with respect to different stages of incidents.
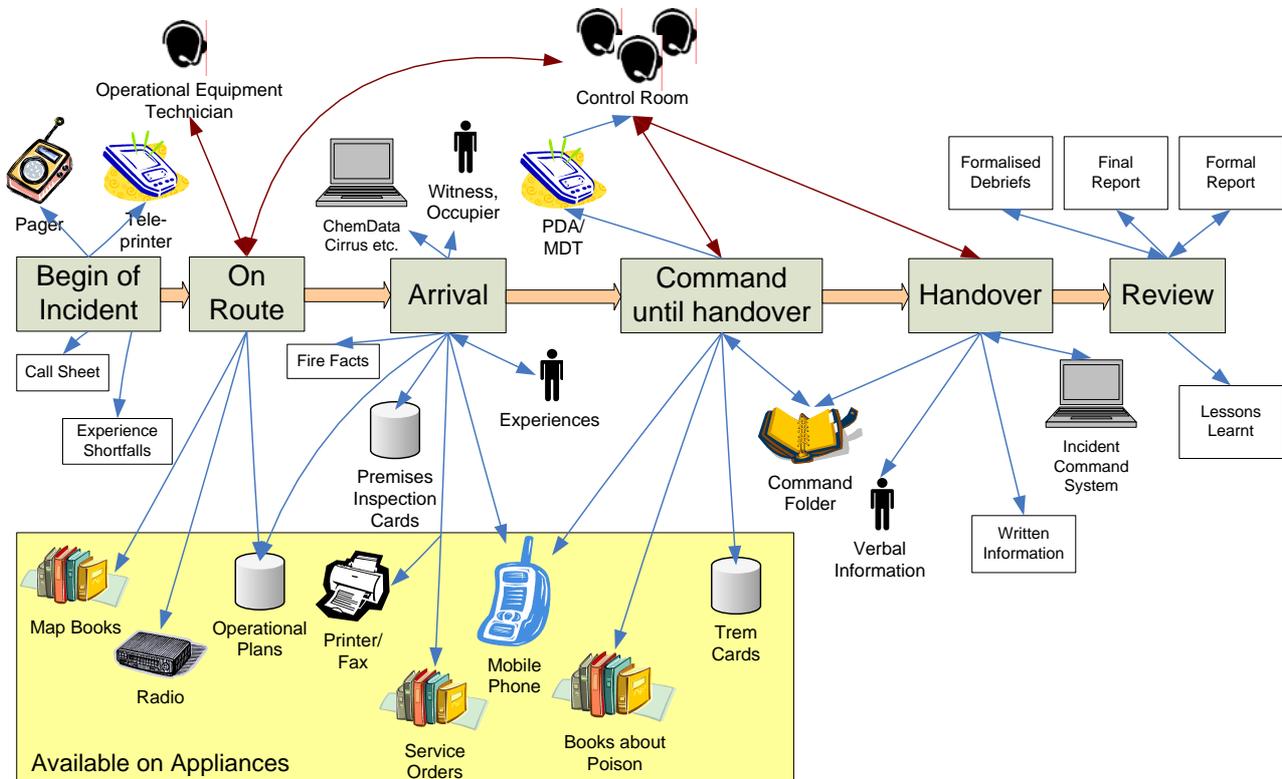

Figure 4: Information Sources of Hampshire

5.2.1.2   London Fire Brigade (LFB)

The first group interviewed at the LFB consisted of station commanders, operational watch commanders, operation station officers, officers specialised on HEMP incidents or chemicals and training officers who look back on two or three decades of working as officers in the fire services. They have experiences in aircraft incidents, industrial premises, and major industrial premises.

The second group comprised crew commanders and watch commanders who were retained fire fighters and sub officers with experiences of between 5 - 13 years. This group is often the first on the scene at an incident. In contrast to the second group, the third group included divisional commanders with at least two decades of experiences and who are responsible for incidents when about 10 appliances are involved.

According to these officers, the occurrence of industrial incidents was about one a week for an average fire station in London, and Hazmat incidents occurred about once a month.

5.2.1.2.1 Primary Sources of Knowledge/Information

To become a fire fighter, all personnel take part in basic training, e.g. house fires training. They learn to use the equipment and to work in a team. For instance, existing Fire-fighter Development Programmes enables fire fighters to deal with and get procedural input used in operations. In particular, fire fighters should get used to get basic science and risk assessment, to recognise signs, and to know dangers of mixed chemicals. For novices, trainee programmes are offered for learning the fire fighting job focusing on communication between novices and experienced officers. Within the London Fire Brigade they count on communication for assuring that everyone has the same knowledge. Beyond procedural input fire fighters receive written information and reference points for further advanced training. Furthermore, within the London Fire Brigade self-studies are emphasised; when having particular interests operatives research in their own interest area.

Within the London Fire Brigade, operational notes denote documents that contain knowledge about incident commands and about operating instructions. Theses notes are originated from prescriptions what to do when a particular set of circumstances happen; meanwhile the notes are seen as guidance notes to make decisions on because the notes describe never the real life. For learning more about incidents operatives can use a training package located at the station. This package consists among other things of operational videos that show how to act at incidents and show case studies acting as negative examples. One purpose is to learn from experiences done by other people on the station or within their team.

Additional information is collated by executing the so-called 11D inspections. This means to go out to premises and major risks for inspecting them and recording major information, number of hydrants, length to the hydrants, locations of water suppliers, life risks, and availability of persons who are responsible for the locations. This information is recorded in a folder with one risk or entry per sheet. Folders are available in each appliance and a spare folder is located at the station.

The LFB works with an electronic filing system, which contains formalised contingency plans of higher risk premises. But there is no mobile access method; either the officer in charge has this information in his mind as there is no access on the incident ground. Otherwise, a computer is available in the control room for getting information so that asking the control for information is possible.

The *Command Support Centre* (CSC) in London provides the mediation of information. For example, the monitoring officer can call the CSC for a report about what has happened on location. Later on, the *assistant chief officer* (ACO) can call the CSC to obtain information. Also the CSC provides the same incident ground support as the command staff offices. Beyond that, it delivers the brigade command unit - in reality a large bus. The Brigade Command Unit with both a station officer and a divisional officer go to incidents and act as a conduit of information flow from control.

5.2.1.2.2 Information Support at the Beginning of the Incident

At the beginning of an incident the fire fighters receive different calls depending on whereabouts. When being on station the fire fighter gets information about the incident, e.g. the address, the route card, the time of call, kind of incident, and information about CRR codes, materials or chemicals. In particular, the information given to the operatives depends on the original source information extracted from the emergency call initiated by automatic alarm or persons. In the latter case, it additionally depends on the experience of the control officers who accept the emergency call; an experienced officer would ask relevant, pertinent questions for getting the best possible information.

When out of the station but near by, a running call reaches the fire fighters, someone coming up to the appliance and physically telling that there's a fire. Without much preparation time and without much information the fire fighters hurry to the incident location.

Otherwise a call can be received over the radio. The driver of the appliance who always stays at the vehicle has to write down the information, which he/she gets over the radio. By using a hand-held radio he/she can call the crew back to the appliance for getting to the next incident.

When senior officers are required at an incident, they are informed about the incident by a pager alert that provides incident information. At the incident they act as specialists and give advice to the incident commander or take over command from that person.

Retained officers get a call from either the control centre or from the appliance in order to come to the fire station. Here, they get a piece of paper that contains the important information.

The divisional officers (DOs) at the station are informed when a*ssistant divisional officers* (ADOs) are mobilised. Moreover, when a 6-pump fire occurs a divisional officer is automatically mobilised as a monitoring officer. In any case, the senior divisional officer (SDO) starts the information gathering process provided by the brigade control. Reliable information can be elicited normally in a three-minute talk with control officers. According to the incident command number control officer can login the control command system and draws the information out of the incidents logs

captured already. After the DO's get a pager message before they leave the station they call the control officer for writing down the requested information.

5.2.1.2.3 On Route

Drive time to an incident in London can be up to 30-40 minutes. Hence, operational information about the incident can be read on the route when being printed on a hard copy, e.g. the copy can contain CRR codes, descriptions of the buildings, risks. Although reading the information is very dangerous the fire fighters intend to pre-plan the incident as soon as possible. All persons involved are informed that everyone has the same information and everyone knows exactly what to expect and how to proceed. Consequently, these persons start thinking about the premises, what to expect, and what will happen. According to the guidelines (operational notes) the operatives act at the location but different officers in charge or different teams make tactical decisions that may deviate form the SOP's balanced upon experience. But reading on route is often very dangerous for operational officers so that this is not practised as a rule.

Whilst on route officers often do not know if there are other appliances coming to the incident. Furthermore, they do not know where the other appliances will come from and which crew-competencies they provide. Information about other appliances is especially important for the retained officers to operate on location, because every watch has its own plan how to proceed. The operation plan is done automatically by the watch and depends on the kind of incident but when other watches are involved they have to be integrated and informed about the plan by the incident commander.

5.2.1.2.4 Arrival

At arrival, operational notes can be used to make decisions about what to do. But first and foremost teamwork and communication are fundamental for the work on location. So-called arrival tactics depend on single watches and emerge from experience. Therefore, they are considered as ad-hoc actions. Watches bring in their arrival tactics for executing the operation. This can be inspecting the location by identifying smoke or hazardous materials or asking people present, such as the gatemen or security guards for more information and for confirming the information already received. Uncovered information is immediately carried to the Incident Commander who is responsible for making decision for the ongoing incident. These initial decisions are frequently life-critical and vitally important for the operation. Therefore, it takes time to identify the problem and to make the correct decision because most fire-related deaths in the UK of fire fighters occur as a result of a bad initial decision. Here, the most important point is the quality of the early decision which has a great impact on the ongoing incident and which sometimes takes considerable time.

5.2.1.2.5 Command until Handover

During the command until handover it is essential to gather information as much as possible. In general, the early officers are involved in gathering information of the incident. Usually, they have to collate this new information. For coping with the large amount of information gathered they have to process it very quickly. In addition, they deal with the urgency and the immediate actions. The officers coming later are more experienced than the initial incident commanders and are able to look at wider aspects and implications affected by the incident; less urgency describes mostly their actions. The officers taking over the incident have a different way of working because instead of gathering information they have people assisting them who filter out important information, thereby providing only relevant and useful information to the Incident Commander.

Depending on the number of appliances involved in an incident, senior officers take over the command. Otherwise senior officers can act as experts and support the officers in charge in doing his job without handing over. Consequently, the officer in charge can learn from the senior officer.

5.2.1.2.6 Handover

A handover takes a few minutes because all information gathered before is passed on to the next officer in charge. In particular, the operational plan of the previous officer in charge is explained to the next one. This conversation of both persons is not recorded. No notebooks are in use to record information. Information related to risks and safety such as life risks, hazards, and update information are handed over verbally.

5.2.1.2.7 Review

After completing the operation incident commanders involved get together in a confidential setting to discuss issues arising from the incident, decisions made, their reasons, and any improvements that could be made for future operations. These discussions are executed based on the incident report sheet that comprises all information about the corresponding incident, e.g. appliances, officers attended, messages. In addition, all observations of the involved persons flow into the discussions. When commanders have used the command planning system, situation reports are available for reviewing the incident operation. Beside the developed command summary, some participants make a few one line notes in a notepad for their own.

The results that come from the meeting are summarised by the chair and included in review reports about new knowledge, e.g. good points and learning points. Besides storing the knowledge into a database, the good points are circulated to all incident commanders and the monitoring officer that attended that incident. The learning points are not confidential to the meeting but are put in a database maintained by *Operation and Training Performance Inspectorate* (OTPI) officer.

Beyond the incident meetings an annual report done by the OTPI highlights any common, persistent problems, which can be addressed in training activities or disseminated throughout the brigade as an analysis of the learning points.

5.2.1.3 South Wales Fire Brigade

Three groups were interviewed within the South Wales Fire Brigade [9] .All three groups comprised experienced officers with knowledge and practical experience of hazardous and chemical materials.

5.2.1.3.1 Primary Sources of Knowledge/Information

Within the South Wales Fire Brigade local knowledge is vitally important for the operatives. This knowledge is gained through practice and experience. It is not written down but in their heads. Retained officers in particular profit by their actual job because of knowing the industrial premises. For example, they work there. Hence, teamwork is preferred because of benefiting from the knowledge of the team members.

Furthermore, they have got aide memoirs called 1(i)d's on the appliances and in the control room that enables to look in during an incident. The 1(i)d's are documents containing official tactical plans and listing risk evaluation of premises elicited through an inspection of the premises. Particularly, water supplies, type of hazards, services, electric, residence, and sleeping risks are contained in the document but this is not reliable information for the operatives because of not being continuously updated. Furthermore, guidelines are available like operational notes. Also Brigade Information Manuals are available that give detailed descriptions on operations in form of flow charts annotated with valuable information.

Special to hazardous materials, hazardous substance manuals are available on appliances containing the UN specification numbers and details of all kinds of explosives. For further information the control room is called via the radio. For dealing with chemical incidents personal protection codes, an extensive manual, is used to know how to proceed.

Paper notebooks are available for storing information but they are not often used. Only when incidents seem to escalate and a fire investigation is probably going to be necessary, do the

officers write facts, descriptions, and decision down for recording the incident. Fire investigations are done by fire investigation officers, who are station officers.

Fire stations of full time fire fighters ensure the generation of risk cards corresponding to important premises. Annual inspections enable the fire fighters to make these cards in form of laminated sheets. On operation the operatives can carry these cards with them.

For personal usage, operation folders enable officers to find brief information with respect to current incidents. Usually, there is no time to look at it. In addition, officers are used to carrying their own notes in their pocket; these could be Hazmat notes from an FSC course or personally written notes.

5.2.1.3.2 Information Support at the Beginning of the Incident

The retained officers are alerted by a pager to get in the fire station. After arriving at the station the officers get a printout that contains varying information depending on the kind of alarm call and the information the control got. At the beginning of the incident, nobody knows whether it is a false alarm or not. If the alarm is automatically caused no information is available about what is involved or the kind of incident; just the address and the premise is known.

When being mobilised officers ask control whether any other appliances are going with them. In particular, they are able to ask control what happens, if they are the first on location, or whether they are part of the *Pre-Determined Attendance* (PDA).

5.2.1.3.3 On Route

On route, the officers contact control in order to say they are mobile and to get updated of the incident. Perhaps, they can assess possible risks on location and prepare the equipment and resources for attuning to the special situation. When an incident is located at a long distance from the fire station, the officer is able to check the equipment on board. They also have to request the Chemical Unit and other special appliances when chemical factories are involved.

On route no decision-making is possible because of lacking information. For example, risk assessment can only be done after receiving definite hints which risks can be expected. When going to a particular type of incident the officer can go through the operation procedure with the fire fighters in advance for preparation purposes. But primarily, the crew gathers information whilst on route because the control propagates all new and important information about the incident over radio. On route, the officers can prepare their crew for the kind of incident they have to expect and which work steps have to be done. But for making decisions more information is necessary, which only can be obtained at the location. Usually, pre-planning concerning manpower and water supplies enables preparation of the crew with respect to the incident.

5.2.1.3.4 Arrival

At arrival the officers have to work very dynamically because of gathering information on the one side and adapting the action plan on the other side. Information may come from security people at the gate or what you see with your own eyes. When the incident becomes larger and more dangerous the IC has to re-assess the circumstances again and to adjust their plan. For further steps, information packages in the gatehouse or TREM Cards if available are used to make informed decisions. For identifying hazardous materials signs have to be recognised, e.g. colour of smoke and what is actually burning.

5.2.1.3.5 Command until Handover

After risk assessment all information is gathered and stored in a paper notebook. Moreover, informative messages are sent to control before that they are written down. Generally, useful information is written down in the incident command wallet during the action. The written information is necessary for the flexible-duty officer.

Officers try to make a plan that depends on changing resources and manpower. By always keeping life risks in mind they start their action plan to avoid an escalation of the incident. Hence, help in form of more appliances or special operation units can be requested according to the situation on location.

Usually, every crew has a radio operator who is responsible for talking to control and for passing the information back. Some messages are taped for getting a de-briefing policy. Moreover, a video camera can be demanded for filming incidents and then bringing it to the control unit.

5.2.1.3.6 Handover

It is up to the senior officer when getting to the incident whether he takes over or not. First, some facts are clarified, e.g. what is involved, what plan is implemented, what appliances are on location, and which resources are available.

5.2.1.3.7 Review

After incidents a debriefing is sent among the crew involved. Special to large incidents, formal debriefs are developed. Generally, the retained officers talk about their operation and exchange experiences after getting back to the station. But there is no communication to the full time crew.

One kind of sharing the debriefs is when sending off de-briefing sheets to the stations involved that enables the crew to make comments and to note concerns.

Furthermore, chats on watch level are held at stations to discuss what went wrong. Here, persons involved have the chance to make clear their point of view with respect to the operation; both good points and bad points are raised for reviewing.

The incident commander triggers the review process when launching a debriefing by requesting persons involved and sometimes using questionnaires. With this in mind, structured debrief processes claim to gather observations and opinions about completed incidents for improving operations sequences and decisions.

5.2.2 Fire Service College Focus Groups

In collaboration with the Fire Service College questionnaires were prepared for interviewing the focus groups. These focus groups comprised young inexperienced fire officers who would have to attend incidents as incident commanders. They are be 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. To distinguishing between these young inexperienced officers or experienced incident commanders profiles are developed.

The FSC revised both the profiles and the questionnaires to assure the usefulness of the focus groups' interviews and to enable a high quality of elicited knowledge as results.

5.2.2.1 Profiles

In order to address a wide range of different profiles of incident commanders, significant characteristics of incident commanders were discussed in advance and profiles created that matched with the intention of supporting young incident commanders.

To create these profiles, several aspects were taken into account that play an important role within the interviews: typical career, age, equipment, and different operation methods of incident commanders or of fire brigades.

The most important aspect is the typical career path of an incident commander. Before becoming an incident commander all officers will have had to work as fire fighters. It is not prescribed by regulations how many years a person has to work before achieving a commander position. Hence, different incident commanders have different experience levels, which was a crucial consideration during interviews and, therefore, two profiles resulted from this aspect:

- Young incident commanders with some experiences as fire fighters
- Young incident commanders without significant experiences as fire fighter

The other aspects also had a great impact on the interview analysis, but they are either indicators for experiences or they do not belong to personnel profiles. For instance, high ages indicate more experience than low ages; equipment or different operation methods belong to external circumstances and not to personnel profiles. For acquiring knowledge about external circumstances the questionnaire contains specific questions.

5.2.2.2 Questionnaires

The questionnaires that were used for the interviews of focus groups were structures in five sections as depicted in Annex 2:

- General Questions
- Information Sources
- Information Support
- Review Related Questions
- Demographic Questions

The general questions consisted of questions related to the experiences that the young officers had encountered. Here, the interviewees can give information about their experiences as incident commanders or fire fighters. Furthermore, it is asked for information about team working within the operational teams as well as for any specific expert knowledge the young incident commanders may have.

The questions concerning information sources take knowledge bases into account from which the incident commanders are able to get information during their daily work. Beyond these sources the interviewees can give information about the communication devices that are available in their fire brigade.

The third section of the questionnaire refers to information support needed in the field. These questions target the elicitation of information about situations when the young incident commanders need information during their work, particularly, which kind of information they lack during work.

Because they play a major role in the UK fire services, review procedures are taken into account in determining whether deficiencies are encountered within review processes. Here, the interviewees can fill out how review processes are executed in their fire brigades. For instance, benefits of reusing review information can be formulated.

Finally, demographic questions enable the characterisation of the interviewees concerning their profiles and personal circumstances.

5.2.2.3 Results of the Questionnaires

This section presents the results of the questionnaires filled inn the 21st of February/2005 by 15 *young incident commanders* (YICs) from 13 different fire services: Hampshire, Fife F&R, Cheshire, Cambridgeshire, South Wales F&R, Lincolnshire, West Midlands, Beds & Luton F&R, Leicestershire, Gramaan F&R, Suffolk F&R, and Strathclyde F&R.

The selection of the participants for this inquiry was done by the FSC. For each section of the questionnaire the results are presented and discussed in the following sections. The full raw data of the questionnaires can be found in Annex 4.

5.2.2.3.1 The significance of the experiences as fire fighter for the YIC

According to the profiles defined in Section 5.2.2.1, the participants of this interview are separated into two categories: The YICs with some experience as fire-fighters (less than 10 years as fire fighters) and the YICs with significant experience as fire-fighter (10 or more years as fire fighters).

During analysis it became obvious that both categories have the same size (7 YICs with some experience as fire-fighters and 8 YICs with significant experience as fire fighters), thus the information is well balanced.

During interview analysis some issues became obvious that are presented in the following:

- 75% of the YICs with significant experience as fire fighters are also experts in at least on other field because of former experiences or roles (e.g. Trauma Instructor, UKSART & HP, Boat handler / Water Rescue / USAR, Domestic Gas Appliance + Installations, RTA Instructor).

- On the other hand, none of the YICs with some experience as fire fighters shows any expertise in any other field.

- The data of the questionnaires does not show any significant differences between these two categories in the usage of electronic/communication devices. The usage of laptops, mobile phones, radio and other communication devices shows no evidence of co-relationship with the age or the experience as fire fighters of the YICs.

5.2.2.3.2 The significance of experiences as Incident Commander for the YIC

During the analysis of the questionnaires beyond the original pre-defined profiles, other significant differences among the YICs became obvious. More focus is put on YICs with different experiences as *incident commander* (IC). Hence, the following groups are identified:

- New Young Incident Commanders (New YICs or novices): the YICs with less than two years of experience as ICs

- Experienced Young Incident Commanders (Experienced YICs): the YICs with two or more years as ICs

Instead of taking the profiles described in Section 5.2.2.3.1 into account the presented analysis focus on the groups defined above.

8 novices and 7 Experienced YICs have been interviewed thus well balanced information is achieved. The first important results of the group classification are:

- The first difference between these groups became obvious by questions on team work. The novices stated that they work with the same team *very often*. In contrast, nearly the half of the Experienced YICs answered that they just *often* work in the same team.

- In the usage of information sources, there are differences as well: novices recognised the *laptop* as information source significantly more than the Experienced YICs. Novices ranked the information sources by the order *laptops*, *radio*, *mobile phones*, whereas Experienced YICs ranked them by the order *radio*, *colleagues*, *mobile phones*, and *laptops*.

### 5.2.2.3.3 Primary Sources of Knowledge/Information

One of the most important results of the questionnaire analysis is the availability and usage of the information sources. Figure 5 shows the availability of the information sources stated by the YICs. The *map books, control room support, chemical facts, operational facts,* and *Hazmat facts* are the most available information sources for them. In contrast, the *decision support systems* are rarely available for the YICs.
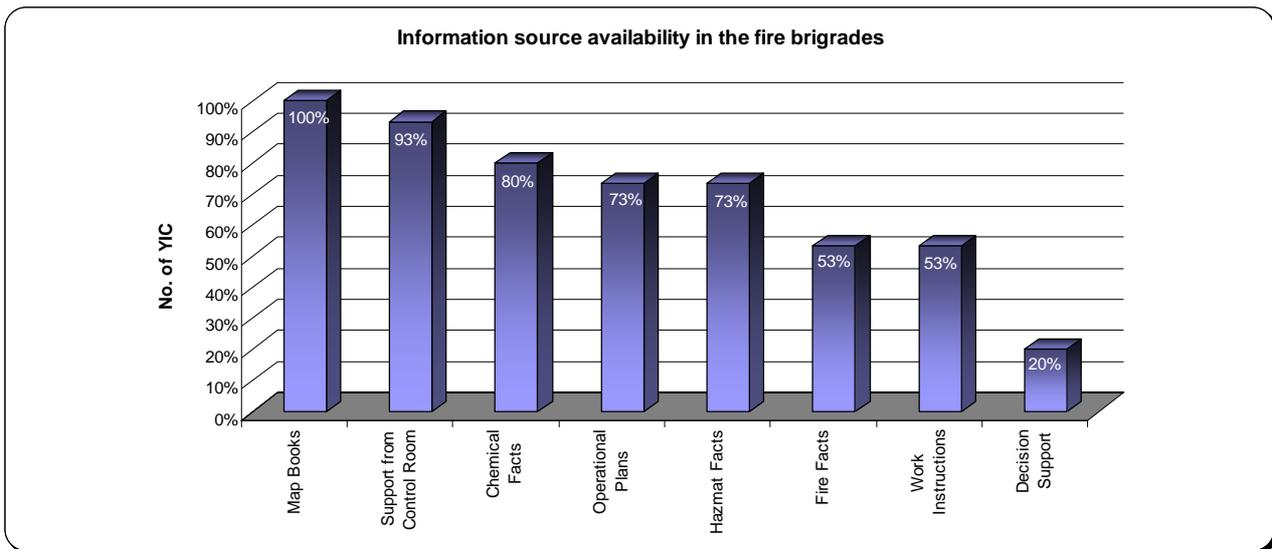
Figure 5: Information Source Availability in Fire Brigades

By going more into detail, it is alarming that only 80% of the YICs have direct access to chemical facts and just 73% of them use Hazmat facts. Normally, these facts are stored in databases or are available as written information so that it should be easy to make them available to the YICs. Furthermore, just half of them have direct access to work instructions which include the important facts of work or decisions.

In terms of information sources it is very important to know which devices are available to access these sources. Therefore, the YICs were requested to specify which communication devices are available in their fire services. Figure 6 illustrates the result of this question.
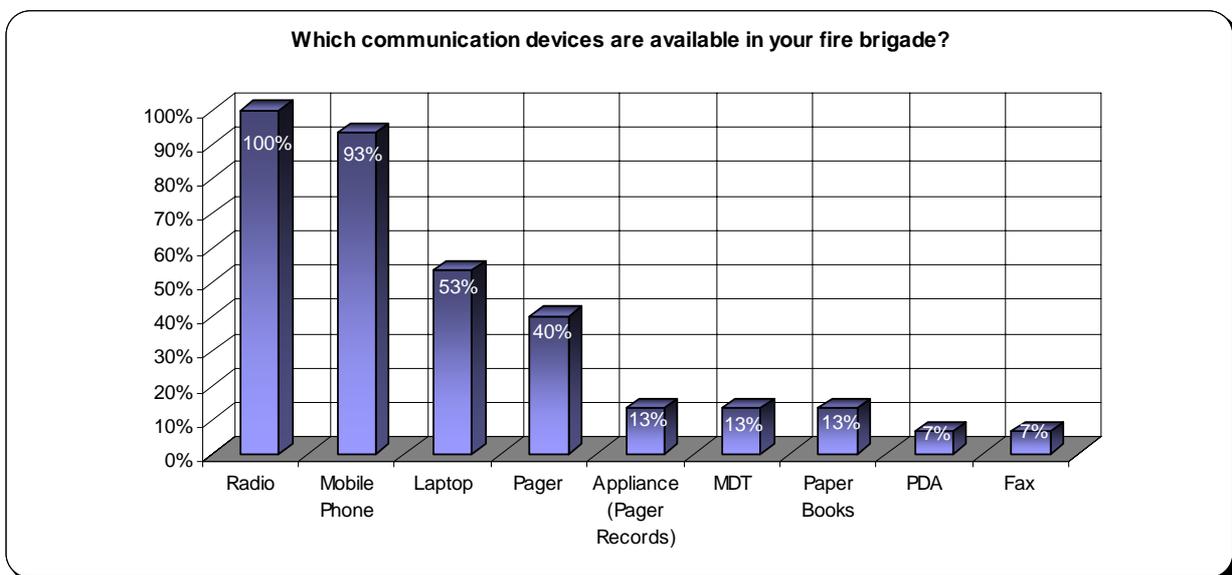
Figure 6: Devices Availability

During work the radio is standard equipment, thus every YIC utilises it and has access to it. Second, mobile phones are available at most of the fire brigades and gain nearly the same importance as the radio. Just half of the interviewees stated that there are laptops on location. All other devices like pagers, Mobile Data Terminals (MDT), paper book, and faxes are secondary.

Table 1 shows the way how YICs can access the information sources that are described above. Most important result of this table is that the YICs use the radio very often. The radio is used as primary connection to the control room. Further it is used to receive information about chemical and Hazmat facts. This means that the control room is charged with tasks like searching for information in databases and other documentations. Second to the radio, the mobile phone is

preferred to access information. By using the mobile phones YICs connect to the same information sources as by radio. In this context, the laptops are mainly used to connect to chemical and Hazmat facts. This circumstance indicates that theses facts are connected by nearly all YICs who have access to laptops (53%) in this way. But even this group additionally uses the radio to query that information.

Table 1: Usage of devices to access information sources by YICs

	Fire Fact	Operational Plans	Chemical Facts	Work Instructions	Map Books	Decision Support	Hazmat Facts	Supp.from Ctrl Room
Radio	20%	7%	87%	7%	0%	20%	87%	87%
Mobile Phone	20%	7%	53%	0%	0%	20%	53%	67%
Laptop	33%	27%	47%	27%	40%	13%	47%	33%
Colleagues	27%	33%	27%	13%	33%	27%	27%	7%
Appliance Record	13%	27%	7%	33%	40%	7%	7%	0%
PDA	7%	0%	7%	0%	0%	0%	0%	0%
Pager	0%	0%	0%	0%	0%	0%	0%	0%

Furthermore, this table provides information about the collaboration among colleagues because 27% of YICs ask their colleagues for decision support. This tops the percentage of the decision support as shown in Figure 5. This leads to the assumption that by answering the 'Information Source Availability' question the YICs did not consider colleagues as decision support. The PDA and Pager play just a minor role to YICs for getting information.

The most relevant information sources and it usages are summarised in the following after having analysed Table 1 and Figure 5:

- **Map Books**: All the YICs identified map books as available in every fire services. YICs access map books by using laptops and appliance records or they get information about routes from their colleagues.

- **Support from Control Room**: The control room is called by radio, mobile phone, or laptops during the whole operation. It is interesting to note that the control room is accessed by mobile phones almost as frequent as by radio. As almost all YICs have access to mobile phones, this communication device is gaining importance in the fires service field.

- **Chemical Facts**: Chemical facts are the third most available information source for the YICs. They access this information mostly by radio. Other common ways to access it are by mobile phone, laptop, and colleagues.

- **Operational Plans**: The operational plans are available to three-quarters of the YICs. The operational plans are available as appliance records, on laptops, and from colleagues who support the YICs with their own local knowledge.

- **Hazmat Facts**: Hazmat facts are also available to three-quarters of the YICs. The access to this information source is done through radio, mobile phone, and laptops.

- **Fire Facts**: Fire Facts are available to the half of the YICs. They access this information by using laptops, by talking to colleagues, by using radio, and by mobile phones.

- **Work Instructions:** Work instructions are available to half of the YICs.

- **Decision Support:** Only 20% of the YICs have access to decision support. This information source is accessed via radio, mobile phones, and laptops; colleagues are asked as well. The most frequent use of this information source is during the incident.

By regarding the groups according to Section 5.2.2.3.2, Table 1 can be split into two tables: one for the novices and one for the Experienced YICs. Observable differences between the access behaviour of them can be found. Table 2 shows the use of devices by New YICs. Beyond the use of radio or mobile phones, the use of laptops to access the chemical facts are very relevant regarding the access to chemical facts and Hazmat facts and to connect the control room. Furthermore, the novices do not have information about chemical facts, decision support, and Hazmat facts on appliances, so they have to contact other persons or to use laptops. Contrary, work instructions are available at appliances that can also be used as decision support normally.

**Table 2: Usage of devices to access information sources by the New YICs**

	Fire Fact	Operational Plans	Chemical Facts	Work Instructions	Map Books	Decision Support	Hazmat Facts	Support from Control Room
Radio	25%	13%	75%	0%	0%	25%	75%	88%
Mobile Phone	25%	13%	50%	0%	0%	13%	50%	63%
Laptop	38%	25%	63%	25%	50%	13%	63%	50%
Colleagues	25%	25%	25%	0%	38%	13%	25%	0%
Appliance Record	13%	25%	0%	38%	50%	0%	13%	0%
Pager	0%	0%	0%	0%	0%	0%	0%	0%
PAD	0%	0%	0%	0%	0%	0%	0%	0%

In contrast, the Experienced YICs relay clearly on radio communication to access the chemical facts as shown in Table 3. In contrast to the novices, the Experienced YICs utilise mostly the radio and mobile phones; laptops do not play an important role. Similarly, the novices access work instructions only on appliances and laptops, whereas Experienced YICs use colleagues and radio as well to get this information.

Table 3: Usage of devices to access information sources by the Experienced YICs

	Fire Fact	Operational Plans	Chemical Facts	Work Instructions	Map Books	Decision Support	Hazmat Facts	Support from Control Room
Radio	14%	0%	100%	14%	0%	14%	100%	86%
Mobile Phone	14%	0%	57%	0%	0%	29%	57%	71%
Laptop	29%	29%	29%	29%	29%	14%	29%	14%
Colleagues	29%	43%	29%	29%	29%	43%	29%	14%
Appliance Record	14%	29%	14%	29%	29%	14%	0%	0%
PDA	14%	0%	14%	0%	0%	0%	0%	0%
Pager	0%	0%	0%	0%	0%	0%	0%	0%

According to both groups, the usages of laptops and radio are investigated and illustrated in Figure 7 and Figure 8.
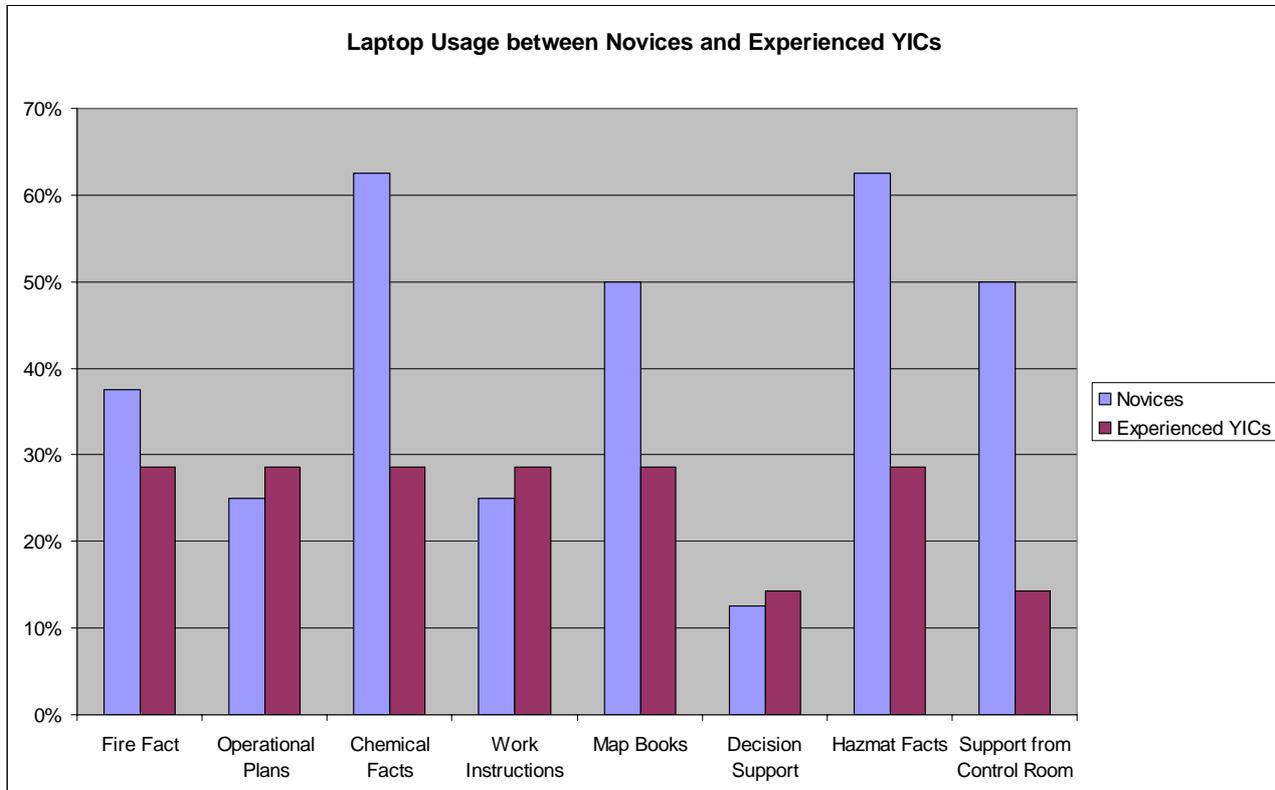

Figure 7: Laptop Usage between Novices and Experienced YICs

The laptop usage is more common among the novices than among the Experienced YICs. Particularly, the access to factual knowledge like chemical facts or map books is done through laptops.
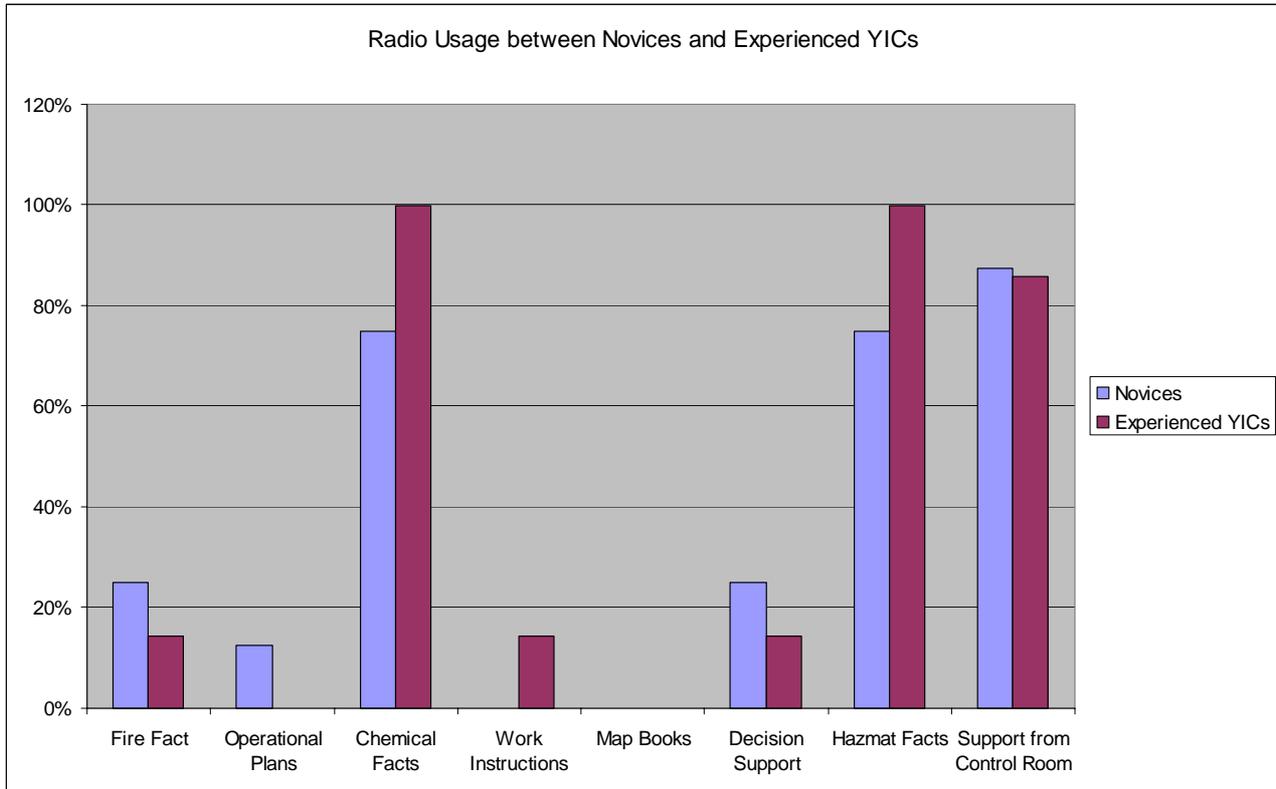
Figure 8: Radio Usage between Novices and Experienced YICs

In contrast, Experienced YICs utilise the radio more frequently. Therewith, the most requests over radio are about factual knowledge, except map books that are already accessed on route.
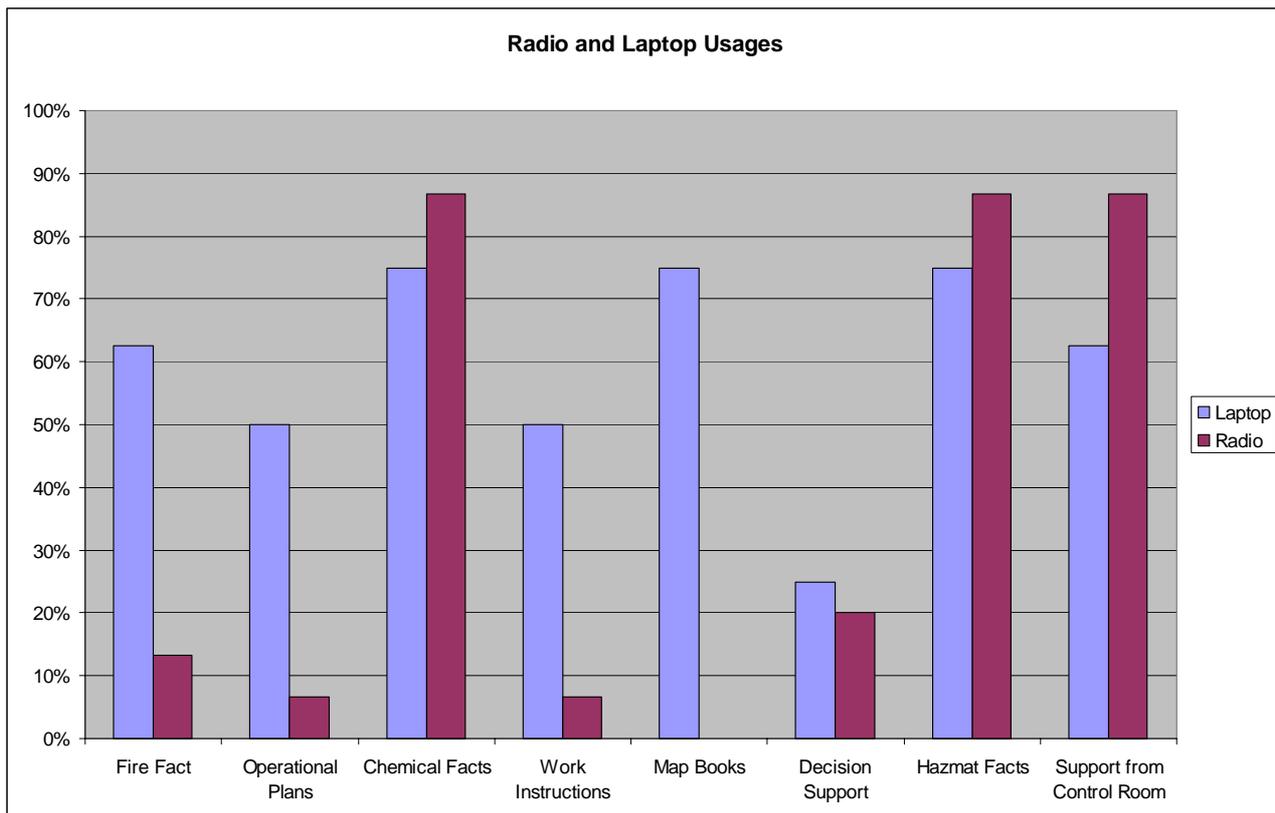
Figure 9: Radio and Laptop Usages

In order to compare the radio and laptop usages the following Figure 9 shows the usages if the devices are available. The figure bases on 8 YICs who have access to a laptop and 15 YICs who have access to radio. For example, laptops are only available for eight YICs but only five of them utilise it for requesting fire facts.

The figure illustrates that the YICs uses mostly laptops when available apart from the decision support. The radio is preferred for accessing support from control room, chemical and Hazmat facts. For requests concerning procedures like fire facts, work instructions and decision support the YICs use the radio less frequently. Operational plans and map books are nearly not requested by radio because of difficulty to describe plans.

5.2.2.3.4 Information Needs throughout the Stages of Incidents

The YICs expressed their needs of information support concerning working procedures and decisions as shown in Figure 10. This figure bases on the question of when YICs need information about working procedures and decisions. The x-axes presents the stages of incident; the y-axes presents the frequency of information needs in relation to the number of YICs and their answers.

This figure makes clear that YICs often need information support during incidents and at arrival because 86% and 70% of the YICs stated that they need information at these stages.
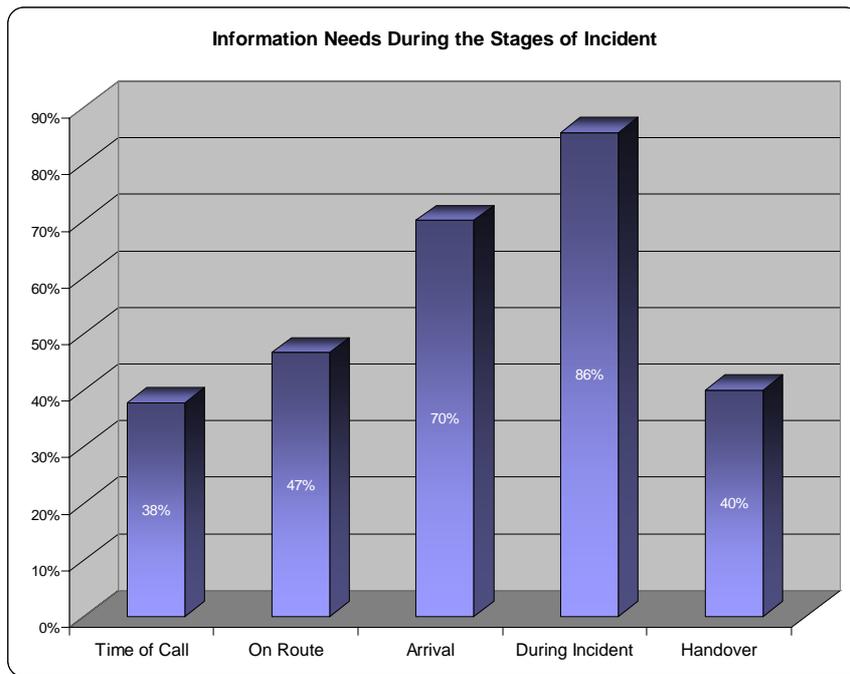
Figure 10: Information Needs during Stage of the Incident

In contrast, the question of when the ICs really look for information gives results depicted in Figure 11. This figure bases on the question of when YICs need information about working procedures and decisions. The x-axes presents the stages of incident; the y-axes presents the frequency of actual information searches in relation to the number of YICs and their answers. This utilised mapping to frequencies enables the comparison to Figure 10. It become obvious that the interviewees underestimated their information need because they estimated their information need lower than they actually look for information.
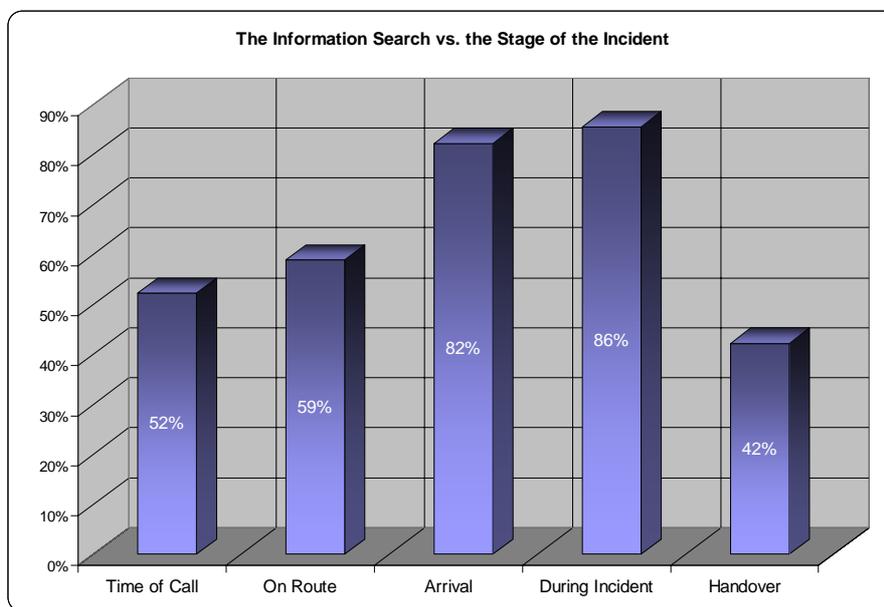
Figure 11: Actual Information Search

Table 4 shows the result of the questionnaires on the relationship between the information sources and the stage of incidents. Concerning information source usage following conclusions can be drawn:

- Fire facts: time of call, on the route
- Operational plans: on the route

- Chemical facts: on the route, during incident

- Work instructions: on the route

- Map book: time of call, on the route

- Decision support: during incident

- Hazmat facts: on the route, during incident

- Support from control room: all stages

Table 4: Information Source vs. Stage of Incident

	Fire Fact	Operational Plans	Chemical Facts	Work Instructions	Map Books	Decision Support	Hazmat Facts	Supp.from Ctrl Room
Time of Call	40%	20%	7%	20%	73%	13%	7%	60%
On the Route	47%	60%	47%	47%	87%	20%	47%	67%
Arrival	27%	33%	27%	27%	47%	27%	27%	53%
During Incident	27%	33%	67%	27%	47%	40%	67%	60%
hand Over	27%	33%	33%	27%	40%	27%	40%	40%
Review	27%	33%	33%	27%	40%	20%	40%	40%

Based on this table results can be observed that incident commanders have access to information sources mostly at time of call and on the route. First, by getting the time of call the ICs get current information about the incidents. So it is traceable that chemical and Hazmat facts are not much available. On the route, they can prepare for upcoming situations. All information sources besides decision support are used for preparing. It is obvious that map books play an important role at both stages for getting to the premises.

During incident, significant percentages specify the high relevance of the information support for the incident commanders. Support from control is as important as chemical and Hazmat facts.

Information Support at the Beginning of the Incident

The information support at the beginning of the incident includes mainly the access to maps and to the control room as shown in Table 4. Further information needs are depicted in Figure 12.

For the YICs who participate in the interview, the most important information at the time of call is the correct and precise address of the incident and the nature of the incident (e.g. type of fire, what is involved). At the time of call it is useful to get the best route to the incident information, taking into consideration the traffic info and secondary routes.

Information Need at the Time of Call
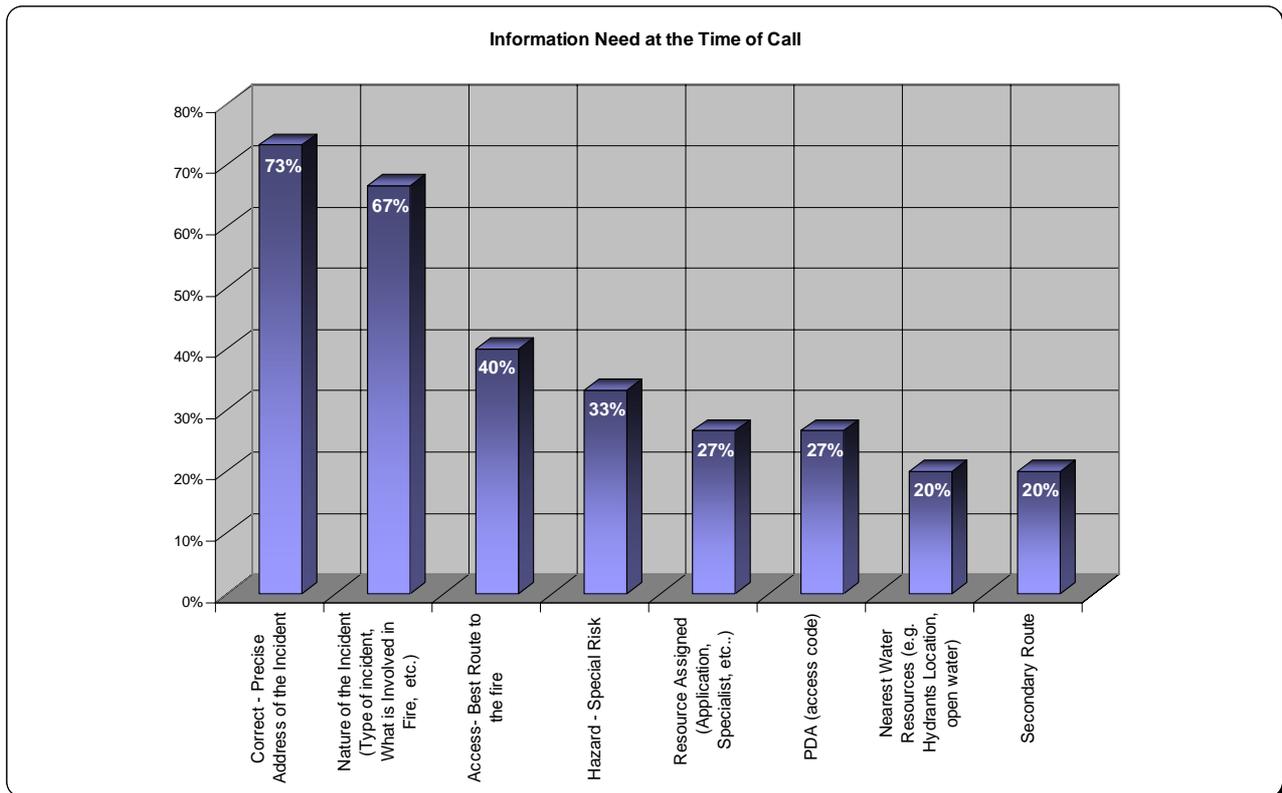
Figure 12: Information needs at the time of call

At the time of call, the interviewees require information about any known risk at the premises, resources assigned, PDA access code, and *Personal Protective Equipment* (PPE) information for the crew. This would allow the YICs to assess the resources they take to the incident and the preparation of the crew.

Putting all together, it is possible to obtain a picture of the information support that the YICs demand at the time of call. The information needs can be grouped in three classes: how to get to the incident, characteristics of incident, and local knowledge about premises. The following description consists of their demands:

The officers receive the alert and get to the fire station. There, the information is prepared containing incident address, any known risk of the premises (based on information previously stored about the premises), any PPE special indications (based on the risks information known until that time), the list of the others resources assigned (e.g. other appliances, specialists, etc), the best route (calculated considering the traffic information), PDA access code.

Depending on this initial information the YICs make their first decisions and plan their actions. Therefore, it is very important for them to get all this information in order to make the correct decision.

On Route

For using the time on route the YICs are able to look for information and to prepare their operation. According to Table 4, map books are primarily used on route. Furthermore, the decisions and actions planned base prior on support from control room. Other information sources like chemical and Hazmat or operational plan are used frequently as well.

As information demands, the YICs expressed they would like to have the information of hydrant locations. This would allow the ICs to plan the location of the appliance and the approach to the incident.

At the same time, it is important that information of any dangers are identified until that time (e.g. Hazmat involved, etc.) and if there is any resource available at the premises (e.g. open water & Services). This last information could be previously stored on the premises information.

It would be very helpful to know the best access point to the incident. The retrieval and presentation of any previous similar incident (local knowledge) is required in this stage based on YICs' statements.

Specific information of the premises (e.g. layout of buildings, plans, building constructions) is highly valuable to the YICs to support the process of incident plan elaborations.

If there is any working procedure (e.g. standard operation procedure) that could be identified based on current information, the YIC should be notified and supplied with access to this procedure information. This will shape the incident plan so far.

Arrival

At arrival the YICs have to collect as much information as possible about the incident. According the interviews YICs collect their information mainly by observing the fire ground. At the same time they have to take decisions and to elaborate on the work plan. In the questionnaire the YICs expressed their need for information about the hazards of the incident and for information about anything on site which can be used (e.g. hydrants, fixed installation, and equipment). Other information like operational plans is already gathered on route.

If they are the first to get there, the risk assessment takes place and the information is gathered. In this process, the identification of any material or situation that could be a danger for the crew that has to be carried out. The identification of the nature of the incident is determined and should be notified to the control room. If any possible dangerous material is uncovered (e.g. cylinders, Hazmats, etc.) the information about how to deal with it and the *standard operation procedure* (SOP) for that incident should be available.

The information of the owner, key holders, occupier or any other premise's responsible person should be identified to advice (in some occasions to gain access and information about the premise). The basic weather report (e.g. wind conditions) for the duration of the incident would allow the YIC to decide the location of the resources and who may need to be evacuated. In order to coordinate the information about other agencies in attendance (e.g. police, ambulances) is required.

Command until Handover

During the command until handover, the risk assessments and incident plan executions are done continuously and interleaved. Here, the highest needs of information occur (see Figure 10), thus the information supports should be well aware of this needs.

The high mobility of the ICs is required because of they have to work all over the premises. In this stage, the YICs need the risk assessment all the time. The chemical facts and information about the specialists on substance, machinery, and/or locations (e.g. Gas, Chemical, Electricity, Rail, etc.) should be accessible. To improve the coordination, the YICs need the information about the external agencies that are involved or could be utilised (e.g. Environment Agency, MET office etc.) during this incident; this information should include contact information. The full recognition information of the incident should to be available to the IC.

During long incidents, the ICs have to be aware of needs for crew relieves, and whether they need other resources. Working procedures and operational hand books are part of the information needs expressed by the YICs during the command until handover stage.

Handover

During the handover process, most of the information is passed in verbal and visual form. Some information is handing over on paper as well. The information that the ICs leave should be handed over to the new IC depending on several factors. Most of these factors concern on the type and severity of the incident. In general during the handover, the following information should be passed:

- The current situation: All relevant information from time of call to present time, including anything carried out which was unsuccessful, the risk assessment, the command folder, messages sent.

- The Incident Plan: what the Incident plan is (tactic), what has been done, which tasks are undertaken, who is doing what, which tasks are remaining.

- Resources information: resource used and still available, any resource needs, how crew deployed, needs of crew (e.g. relives), needs of other resources (e.g. fuel etc.).

A lot of this information has been collected during the previous stage of the incident and it should be available to the first ICs. There is a demand on capturing this information gathered so that it can be presented to the next IC as suitable as possible.

Review

At the end of the operation the review process takes place. The product of this process is a review report. In the case of the interviewees, there is always one review process at their fire services and they always take part in the review of the operations in which they are involved. In most of the cases the whole crew take part as well.

The purpose of the review report is to document the information of incidents. Consequently, regarding the reports ICs and fire fighters are able to learn from good and bad experiences on incidents.

Only 25% of novices think that the report is integrated into work instructions. Only half of them think that the report is integrated into training processes. One third doesn't know what happens with this report.

On the other hand, all of the experienced YICs think that reports are integrated into work instructions. And all of them think that reports are integrated into training processes.

5.2.2.3.5 Suggestions from the YICs

The questionnaires are prepared for giving interviewees the chance to make notes concerning future information support on this topic. The most important suggestions and motivations are figured out in the following:

- More mobility: the communication devices should provide sufficient accessibility that enables ICs to gather information without returning to the Cab.

- Right information: Information at the right time at the right level of detail (e.g. not too much at beginning and not too detailed).

- Suitable information: Information on possible products or substances as soon as possible and their handlings.

- Notification on incident change: The ICs should have notification on incident changes (e.g. risk assessments changes, new Hazmat, etc.) as soon as possible to take to proper actions.

- Continuous communication: It is important for ICs to have continuous communication with other decision takers (e.g. control room, specialists, etc.) and crews.

- Right devices for the right job: e.g. computer screen in cabs. All the information should be available at a touch screen in cab.

- Special devices: The use of special devices like G.P.S. and route-finder could make the decision and work process more fast and reliable. These devices can integrate route-finders that take into consideration the traffic information of the routes on that specific day and time.

   On-line weather map: weather information is very important to ICs to do their job, so a easy-to-use device for getting weather conditions is a demand.

- Clear and concise information: More clear and concise information available on route are required, so a better plan of action can be thought of. Sometimes, it is difficult to rely on poor radio communications that result in delays of decision making.

- Risk Assessment: specific risk information would be an advantage to the IC, e.g. risk cards.

- Information support: all water supplies should be listed automatically, 3D view of building should assist to positioning the crew and resources, and information should be available to all crew (not just crew commander).

5.3   REQUIREMENT ASSESSMENT

Based on the interview descriptions some details of the current state of working and information sources become obvious. Consequently, both points are completed in this section. Furthermore, the user requirements are represented and argued that lead us to conclude the use cases, which sketch the functionalities of the AMIRA system.

5.3.1   Current State of Working

The AMIRA project addresses both mission-critical and literally life-critical situations for mobile workers in a hazardous and fast changing environment. In that scope, time-critical incidents are focused that demand highly flexible processes and an optimised collaboratively working in the field. The UK fire services are hierarchical structured with regard to existing roles. Roles specify responsibilities for incidents and for special tasks, e.g. incident commander and HAZMAT officer. Beyond that it is usual that in association to roles different knowledge can be expected.

In particular, the documents related to Brigade Orders, Control Room Notes, and Operational Notes give information with respect to the current state of working as they contain descriptions of working procedures of the fire service domain. Acting as guidelines these detailed documents enable fire fighters to follow the recommended actions in order to do their job. Besides descriptions of work procedures, the documents also contain information about how to contact experts or other responsible organisations. Usually, the contact information refers to telephone numbers. Other communication methods were not mentioned by the documents.

While wearing operational kits such as breathing apparatus or heavy gloves, accessing information written on paper or stored on laptops is very cumbersome. Therefore, important processes frequently occurred within the fire service domain are pointed out.

5.3.1.1   Representative Processes

Representative processes within the fire service domain are formulated if they occur frequently and that they have characteristics that concur with the current state of working practices. The first working process is the need of information during work. The second process concerns the asynchronous collaboratively working.

The processes of needing information during work can be described as processes in which fire fighters lack information while working. Because of the wearing fire kits, accessing information written on paper or stored on laptops is very cumbersome. Moreover, sending requests to the control centre means returning to the appliance to get the necessary information because not everybody has mobile phones. Beyond these difficulties, a crucial point within the fire service domain is that a large amount of information and information sources exist which have different access methods and from which different fire officers makes different statements concerning the reliability.

The asynchronous collaboratively working processes means reviewing activities when fire fighters or fire officers have to make reports about their operations. For example, by handing over to a new command officer complete information is collated about the incident to support the new officer in seamlessly taking over the control. Otherwise, the review processes are executed by incorporating comments of all persons involved. Normally there is no efficient reuse of the information collated because of no integration processes into the databases. Up to now, the information related to feedback and the lessons learnt are separately captured in a database on which officers and fire fighters have access but which are normally not used.

5.3.2   Information Sources

After analysis existing documents and executing the interviews with the end-users the following information sources are pointed out:

- Brigade Orders
- Control Room Notes
- Operational Notes
- Documents about risk assessments
- Documents about fire control plans
- Fire Facts Books
- Intranet
- Control room (Internal Experts)
- External experts
- Map books
- Witness and occupier
- Hazmat Databases and Chemical Databases
- Local knowledge
- Experiences from colleagues
- Call Sheets
- Premises Inspection Cards

This list does not claim to be complete but it gives an impression of how many opportunities fire fighters have to get information. Obviously, the list contains both structured information (e.g. databases) and unstructured information (e.g. documents). Moreover, experts are involved in the information support process for providing tacit knowledge that is not already written down.

Thereto, different communication devices and mobile access methods are available among the 58 different fire services. A few devices are listed:

- Laptop
- PDA
- MTD
- Mobile phone
- Phones installed in the appliances
- Fax
- Terminal access

But it is not common that all fire services have access to the listed communication devices; some fire services are working exclusively with information in paper form. In contrast to that, in some fire services it is usual that every ranked officer has a mobile phone.

5.3.3   User Skills

Based on the interview transcripts several user skills were identified that relate to the job of fire fighters and, therefore, are necessary for undertaking that work. By eliciting typical user skills the study aims to uncover starting points for supporting end-users and for alleviating operational procedures. Primarily, the following user skills became obvious during the analysis of the interviews and existing documents:

- Keen perception for capturing situations
- Flexible acting in a fast changing environment

- Retaining facts in memory

Both the first and the second user skills are highly time-critical in emergency situations as the fire fighters work. The keen perception for capturing situations is the precondition for identification the kind 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 to misconceive incidents that leads to a crucial issue. Above all, it depends on the reports of fire fighters how incidents commanders make their decisions.

The last skill concerns the 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 officers 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. For instance, much information exists that deals with fire fighter safety and that is essential to know for all of the fire fighters. Another point is that knowledge is always under development because of changing work procedures, changing circumstances or because of new technical infrastructure.

5.3.4 User Requirements

The following user requirements are deduced from the interview transcripts described above; they are also based on the analysis of existing documents and FSC knowledge bases.   Different fire services have different requirements with respect to information support. In this study, only those requirements that are common between UK fire services have been taken into account.   It is also possible that some of the more generic requirements also meet the requirements of all UK fire services.

Analysis of the interview transcripts highlighted several specific issues. The main issue being the surfeit of information sources that are in use in the fire service domain. Some fire fighters talk about the danger of information overload or overflow. Triggered by this overload of information, a large number of text based documents have to be read in order to determine the specific information wanted. End-users are looking for "some form of computer, inside the fire appliance that is easy to use and to print and to pass on to the incident commander". Such an information support solution is planned by the AMIRA vision to provide mobile workers with information relevant to their current work.

In accordance with previously presented information sources, interviews, and representative processes some user requirements were encountered during the knowledge base interrogations and the analysis of the interviews. Besides focussing on the main requirements the following are drawn as conclusion:

- Mobility: When supporting mobile workers, the mobility of the operatives must be ensured. The envisaged information support must be able to provide information at any location the mobile worker can be.

- Easy to use: 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. It is therefore necessary to develop adequate access methods such as speech-based request possibilities whereby it is not necessary to use one's fingers or hands.

- Reduction of the number of systems in use: As a result of the analysis of existing documents and existing studies within the domains, there currently exist a large number of information sources and different access methods. To facilitate improved working on location the number of systems in use needs to be reduced.

- Standard of mobile data systems: According the CFOA study the fire service domain lacks of standardised mobile methods to access data.

- Information support during work: In order to improve their use in practice, any computer support system would have to be seamlessly integrated into the work procedures of mobile workers. Due of highly flexible working processes in the field, the information support has to

be adapted to such processes. For example, fire fighters have a demand for getting information about hazardous situations or informative hints when such instances are discovered.

- Core information: The incident commander 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 concentration must be on the core information.

- Information capturing: Based on the interviews described, a need for updating procedures becomes obvious. Up to now, update processes are not held very frequently, so that information sources become less reliable. Structuring of update and review procedures would be a huge benefit for the fire service domain.

- Knowledge exchange: Supporting knowledge exchange means improving the collaborative working among mobile workers because everyone can access the necessary data of the corresponding incident. In truth this must be via the Incident Commander, although it is feasible that the control room could have access to the same information requested and given to the Incident Commander.   In addition, it is an added value when all relevant data of an incident is gathered for knowledge exchange. In addition, the data gathered can be useful to be integrated into reports about the respective incident.

- Search on structured and unstructured data: Regarding the large amount information sources that occur in different forms, e.g. structured and unstructured. This data has to be integrated into a computer-based support.

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

- User profiles: Because persons involved in an incident have different knowledge the information support system has to consider different levels of information presented as results. Therefore, user profiles including roles will have to be integrated in the information support.

- Connection to control: The collaboration with the control room personnel needs to be taken into account.

This list of user requirements is not exhaustive but establishes an understanding of user needs within the fire service domain. To cope with the complexity of these requirements the conception of the use cases is reduced for claiming to be realisable, feasible, and application-driven.

5.3.5 Use Cases within the Fire Service Domain

In the scope of AMIRA, the goal is to develop a system that gives support to mobile workers during their daily work. For a better understanding how the system will work, use cases enable representations of interactions between end-users and the system; also one or more scenarios are associated with a single use cases for sketching the interactions.

The presented use cases are elaborated by considering the elicited user requirements. In particular, in order to identify scenarios the current state of working practice will have a significant impact on the examples of use, indicating deficiencies during work and uncovering benefits facilitated by information support. In this sense, three use cases have been identified as shown in Figure 13.
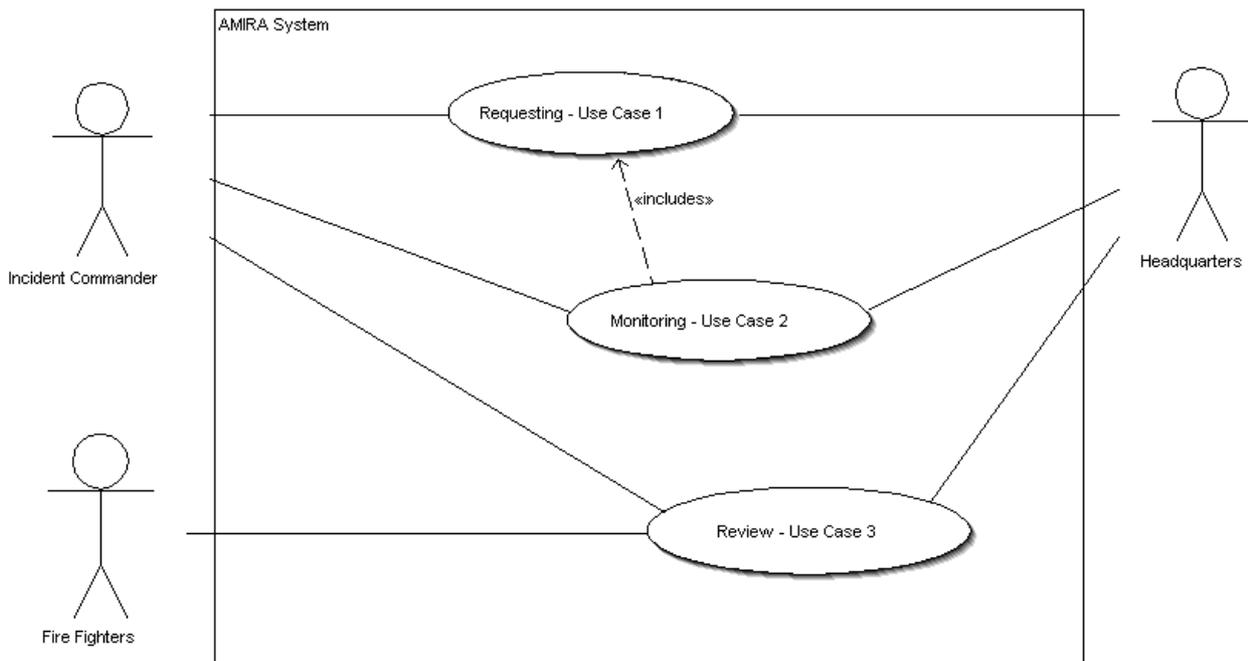
Figure 13: Overview about the Use Cases

The first use case enables incident commanders to ask a question and to get a response from the AMIRA system.

The second use case includes and uses the first case to monitor the incident commander in action and to pro-actively support the control room in getting additional, context-base information.

The third use case triggers a review process to the respective incident for information capturing and development of lessons learnt.

In the following sections, these use cases are described in detail for pointing out sub-processes provided by the AMIRA system. Therefore, the use case representations are structured in the same way. First, a short description gives an overview of the targeted example of use. Second, an illustration represents the use case for outlining the interactions between users and system. Relationships between actors/agents and the system are marked by lines; relationships of the sub-processes are specified as inclusions and extensions of others. In addition, the illustrations of the use case are also expressed by an order of events. Thereby, every event on behalf of users is denoted by "U" assigned to a unique number. "S" stands for system response. Finally, the scenarios sketch the examples of use in order to give realistic situations in which the envisaged system could be applied.

5.3.5.1 Use Case 1

Within the fire services the Incident Commander (IC) is the ONLY person who is in charge and responsible for the decisions made on location. Therefore, all fire fighters involved provide him/her precise known details of the incident. The IC is then able to make decisions on how to proceed. Consequently, there is a demand for supporting the IC when he/she lacks information necessary for decision-making and in estimating current resources. But the IC does not have the time to go back to the fire appliance and to look for information. Normally, he/she stays close to the incident and close to the fire fighters. In this case, the first use case focuses on supporting the IC in making requests and receiving answers by utilising an AMIRA mobile system.
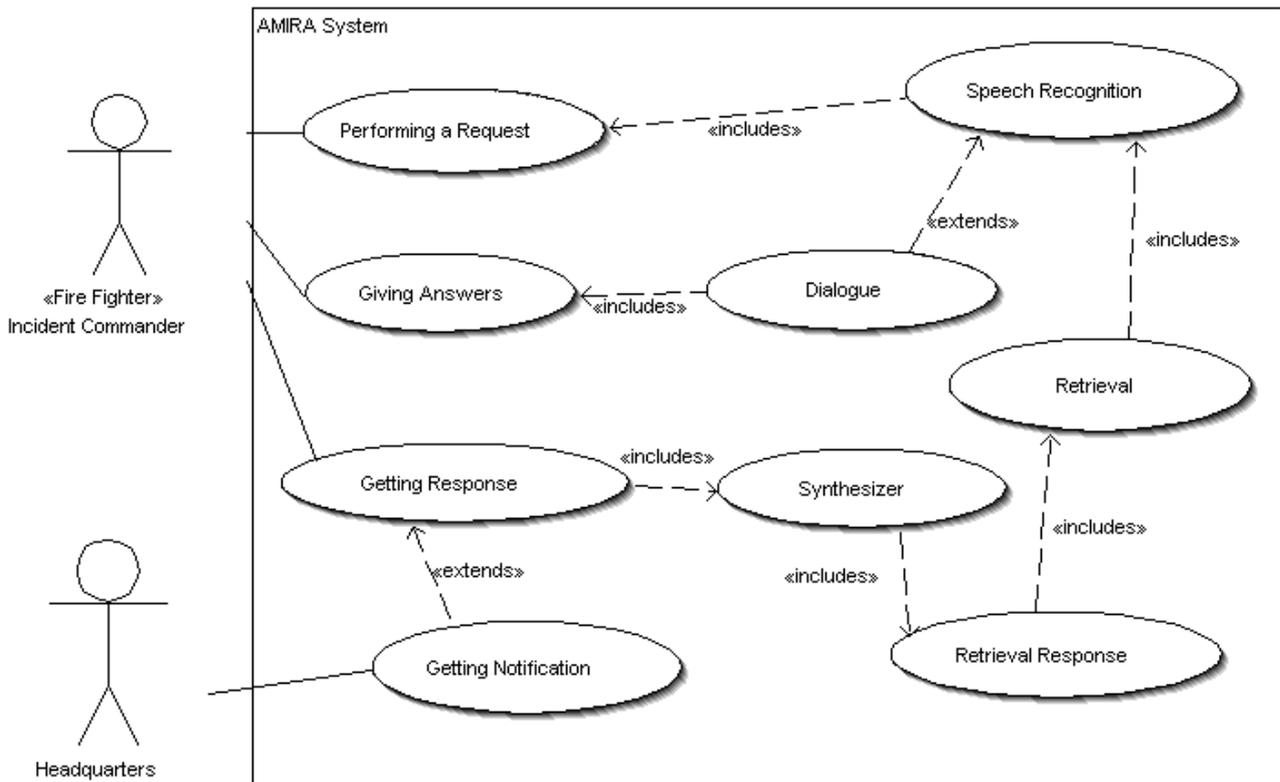
Figure 14: Use Case 1

Figure 14 offers a closer look on the presented use case and shows its details. Accordingly, the use case is broken down in order to uncover relationships between sub processes provided by the system. The first use case can also be expressed by an order of events that describes the obvious course of events as listed in the following table.

Event	Description
U1	The incident commander makes a spoken request.
S1	Speech recognition component analyses the spoken request.
S2	If necessary the dialogue component starts an interactive dialogue either to get confirmation about the analysed request or to request more information.
U2	The incident commander gives answers to this request for additional information.
S3	System routes the query to an appropriated search engine and executes a retrieval request.
S4	System gets answer from the retrieval service.
S5	The synthesizer transforms the result into natural language for the incident commander.
U3	The incident commander gets the spoken response. This response can be the final response; can contain multiple-choice options for narrowing down the result set; or contain a request for further information.
U4	The control gets a notification about the question and response to obtain information of the situation on the incident ground.

One possible scenario of the presented use case is when the IC arrives at the incident, fire fighters tell him/her many facts about the incident but he/she does not know how to interpret the facts or

how to act. For example, one fire fighter comes to the IC and reports that some burning plastic crates have been found, but when water is put on them, the flames appear to be bigger. The action of putting a jet of water on the plastic causes it dispersal into smaller pockets by spreading the liquid plastic, which further fuels the flames. This in turn produces more radiated heat. In this scenario, the IC makes a request to the AMIRA system, describes these facts, and gets instructions how to act and what has to be taken into consideration for further decisions. This situation is also interesting for the control room, in that they get early notification about the burning plastic crates.

One other scenario can be that a fire fighter has found a cylinder with unknown abbreviations of chemicals. These abbreviations can be spelt out to the IC who can make a spoken request to the system for information about which chemicals are in the cylinders. The response is sent to the IC as well as to the control as information.

5.3.5.2 *Use Case 2*

By monitoring interactions between mobile workers and the AMIRA system the latter can elicit information related directly to the operation in which the operatives are currently working. Thereby, the AMIRA system is able to pro-actively present information in the form of logs as shown in Figure 15. After or during the operation these logs can be used as part of the operation debrief protocol or for reproducing actions or decision made during operation.
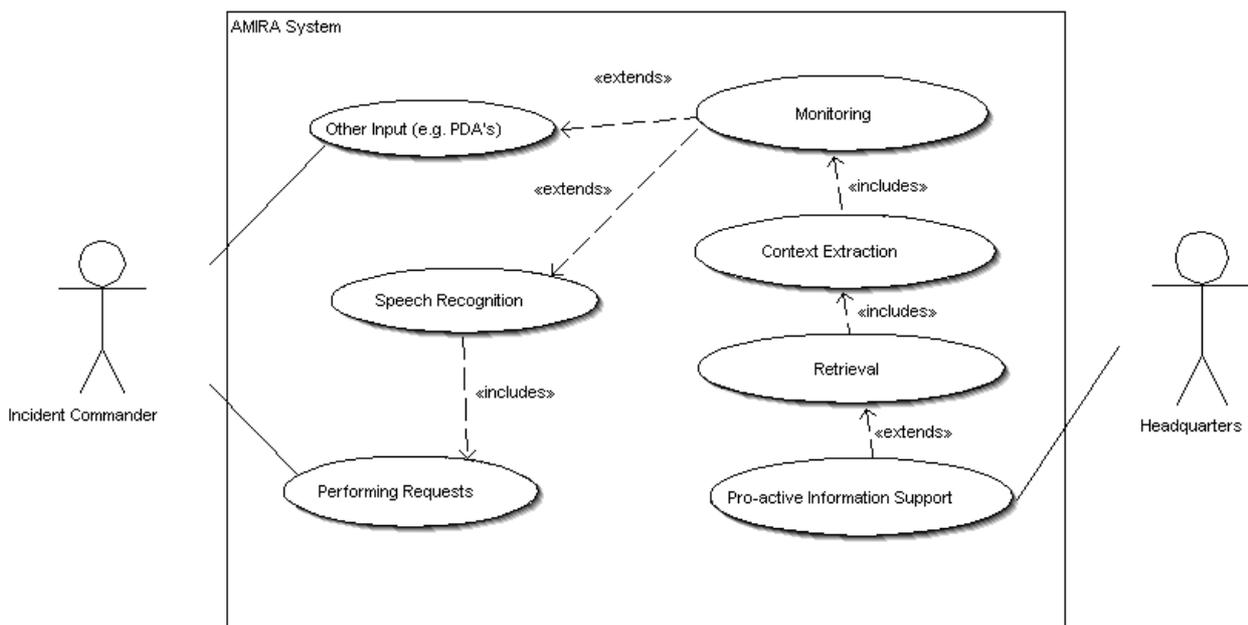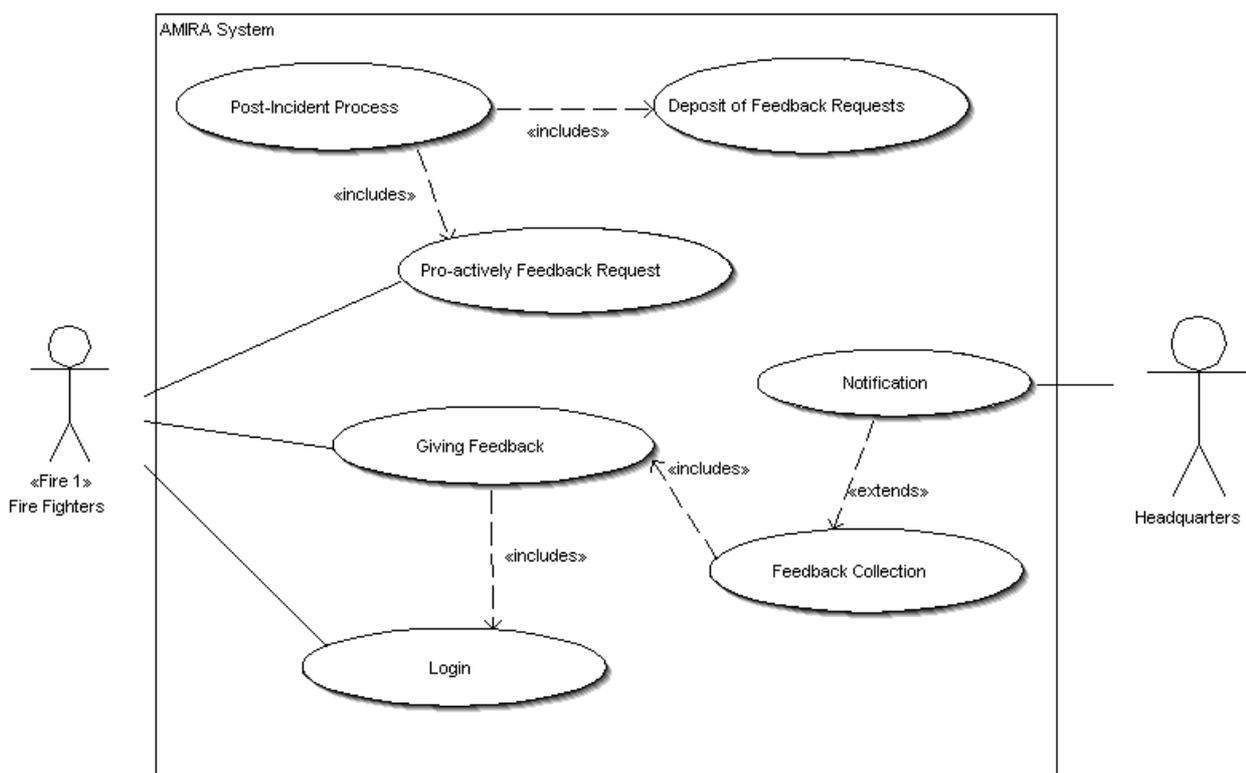

Figure 15: Use Case 2

Fire fighters work collaboratively at the same incident, in this case at "Fire 1". For the control room it is important to know every changing issue in the scope of "Fire 1". Therefore, information retrieval is performed based on monitored information extracted from the user interactions that are described in more detail in the following table.

Event	Description
U1	Incident commander makes verbal request relating to the current incident.
U2	Additionally, the incident commander probably utilises other communications devices such as a PDA or mobile telephone during his/her work.
S1	Speech recognition component analyses the spoken requests.
S2	The AMIRA system monitors all inputs from the incident commander, including those not directly concerning requests to AMIRA
S3	System interprets the monitored inputs semantically and determines the context.
S4	The system starts a retrieval process to get important context-based information.
U2	The control room is pro-actively supported in being presented with context-based information with respect to the current incident.

One possible scenario is pro-active information support. For instance, in time-critical situations it is imperative that the control room are fully aware of the activities of fire fighters involved in the incident. The control room collates all known information about the incident to obtain an overall impression for making correct diagnoses. Consequently, all interactions of the IC with the system are monitored and logged by the system. Based on these logs context-based information is extracted. By presenting the control room with this context-based information, control is supported with important information about what is happening on the incident ground.

5.3.5.3 Use Case 3

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

Figure 16: Use Case 3

As depicted in Figure 16 the third use case is triggered by the AMIRA system for pro-actively initiating feedback and review processes, a detailed description is contained in the following table.

Event	Description
S1	After an incident, the AMIRA system starts a "Post-Incident" process.
S2	This process initiates a feedback request for involved persons.
U1	At some future date the fire fighters who were involved in the "Fire 1" log into the AMIRA system.
S3	The system requests the fire fighters who were involved in the "Fire 1" to provide specified feedback concerning the operation.
U2	Fire fighters involved in "Fire 1" give feedback related to the operation.
S4	The feedback is collected by the AMIRA system.
U3	Control is notified that feedback exists and they are responsible for integrating the feedback into the existing databases. The control (or another division of the fire services) can analyse the feedback to decide if further information has to be acquired or if existing information has to be modified.

One scenario can be the management of collaborative post-incident analysis of the operation. This encompasses pro-actively asking those involved - ICs and/or fire fighters, for information about their actions concerning possible modifications to guidelines or other information used. Furthermore, it is possible to support methods for capturing information about the incident itself, e.g. in order to alleviate handover procedures. For achieving reliable information sources, control personnel can integrate new or additional information into the databases that contain guidelines or documents, by using their own update procedures. The incident commander would benefit directly due to the need to start the recording process at an early stage.

5.4 EVALUATION

At the fourth analysis level, the AMIRA user partners and technology partners were involved in the evaluation process: verifying and validating the user needs determined in the requirement assessment above. The user partners were responsible for evaluating the elicited user requirements and elaborated use cases. The technology partners were responsible for proofing the use cases with respect to technical feasibility.

In conducting the evaluation, different aspects were reviewed by the user and technology partners:

- Reading the first and second interim reports of socio-economic study of user needs (D2.1.0a and D2.1.0b)
- Checking the interim reports for accuracy
- Proposing modifications, adaptations, and extensions
- Adjusting the modifications, adaptations, and extensions in the reports.

Following these reviews, corrections were made in the documents; new knowledge was captured by the evaluation section. In addition, discussions with experts, colleagues and with domain specialists enabled the accuracy, applicability, and usefulness of the presented results.

The evaluation was undertaken from three perspectives. First, the domain experts evaluated the user requirements and the use cases, because both have a great impact on the envisaged AMIRA system. Second, the technology partners verified the use cases in consideration of their own technology. Finally, interdependencies between the socio-economic results and technologies were determined that represent the technological benefits with respect to user requirements.

5.4.1 Evaluation by the Domain Experts

The main goal of this evaluation was to gain user acceptance and to achieve a high quality of evaluation. Therefore, the FSC domain experts, who have considerable knowledge about the domain, evaluated the user needs In particular, the FCS experts have hands-on experience as fire fighters and are also able to estimate the benefits of the envisaged AMIRA system.

Domain experts involved in this evaluation discussed the results of the study with colleagues who themselves have many years of experiences in the fire services, especially in situations where they have encountered the problems of young inexperienced incident commanders on the incident ground. The in-depth knowledge available at the FSC ensured the evaluation quality. Consequently, the domain experts gave feedback to all analysis levels as follows:

5.4.1.1 Evaluation of Knowledge Base Interrogation and Analysis

Some of the knowledge base interrogation and analysis presented results that were partially obsolete as it was based on information and data sources that are already a few years old. However, many of these documents and information are still up-to-date and are estimated as very useful and informative concerning this study, albeit that some details have changed:

- Fire & Rescue Services ACT 2004 replaced the Fire Service ACT 1947 bringing a wider remit for the service, which now includes fire fighting, fire safety, road traffic accidents, and emergencies.

- Sec 1id is now replaced by sec 7(2)d.

- An important issue of the new ACT is that it no longer includes a description of who is in charge of emergencies.

- A new, nationally agreed personnel development system for the whole UK Fire and Rescue Services is being established - the Individual Personal Development System (IPDS). This is based on a set of National Occupational Standards (NOS) that defines what people have to do at different levels and what they need to know and understand.

5.4.1.2 Evaluation of Interviews and Questionnaires

The RIMSAT project considered end-users who required support when dealing with chemical incidents. But for the domain experts involved in AMIRA, it is more important to focus on the first attendance (first on the scene) incident commanders, and to focus on general decision-making based on 'poor safety'. Therefore, a request has been made for the acquisition of more and new knowledge about first attendance incident commanders - who generally lack sufficient experience and knowledge. At present, there is a lack of information related to the needs of these young ICs. To cope with this, additional questionnaires were developed and further interview sessions prepared. The interviews were held as part of focus sessions undertaken by the FSC during February 2005. The analysis of these additional focus group sessions is already described in Section 5.2.2.3. In summary, the analysis of the focus group interviews emphasis the already concluded user requirements and use cases; not modifications to former results were necessary.

5.4.1.3 Evaluation of User Needs

The results achieved in the requirement assessment were revised and verified in collaboration with domain experts. They were able to understand the conclusions drawn and, bearing in mind the evaluation criteria, considered them to be accurate, useful, realistic, and relevant for their domain.

For instance, the crucial issue for the end-users relates to the usability of the envisaged AMIRA system, which must support mobility, easy of use, information support during work, and core information. The domain experts envisage an AMIRA system that is appropriate to be used on the incident ground and that provides the user with suitable information very quickly.

To achieve the user applicability of the envisaged AMIRA system, the domain experts discussed the use cases and evaluated them on a theoretical level. According to these discussions, the use

cases were found to be correct, which is emphasised by the associated scenarios. These scenarios give an idea of realistic and practicable use of the envisaged system.

5.4.2   Use Cases from the Technological Point of View

From the technological point of view Kaidara, Fast, and DaimlerChrysler revised the elaborated use cases by reading the two interim D2.1.0 reports and by participating in several AMIRA meetings. The use cases were presented in the following meetings:

- Project board meeting in Paris (July 2004)

- Technical meeting in Trier (August 2004)

- Technical meeting in Ulm (September 2004)

- Project board meeting in Moreton-in-Marsh (October 2004)

- Project board meeting in Paris (December 2004)

Between July and December 2004, the use cases were adjusted based on information arising in the meetings that related to the domains or technical aspects. The technical partners came to the conclusion that the use cases were appropriate for their technologies with respect to the AMIRA focus described above.

5.4.3   Interdependencies between User Needs and Technologies

In verifying the socio-economic results, the technology partners pointed out some interdependencies between user needs and the AMIRA technologies as listed below:

- Due to the large amount of different information sources the combination of search and CBR technology provides the possibility to distinguish between sources. Therefore, each source is assigned by quality scores, so that highly structured and high quality sources are preferred. If no match is received, the next source is used, e.g., a free-text source.

- The speech dialogue system combined with a headset system is able to provide a seamless integration of the envisaged AMIRA system. Then, end-users can ask their questions by speech and will get response without using their hands.

- To avoid information overload, short abstracts of the corresponding documents could be useful, or a 'smart' request to the user for more information in order to differentiate the case base. Tagging documents with their inherent quality or usefulness may also help; multiple-choice options for narrowing down the result set could be applied.

- By providing user profiles the AMIRA system is able to distinguish different end user and to consider self-learning profiles based on users' past interactions with the system.

6   VEHICLE ROADSIDE ASSISTANCE DOMAIN

The second AMIRA domain is called the vehicle roadside assistance domain, and focuses on vehicle repairs in-situ to ensure the vehicle is back on the road as quickly as possible. Representing this domain is the *Transport Engineering Workshop* (TEW) of West Midlands Fire and Civil Defence Authority. TEW are described and discussed in detail in order to show the starting points for the AMIRA vision.

Typical processes at TEW can be characterised as business-critical as they comprise jobs that must ensure vehicles are back on the road and operational as quickly as possible. Furthermore, these processes can also be described as time-critical because the time factor has an impact on the mission and business objectives of TEW.

6.1   KNOWLEDGE BASE INTERROGATION

In contrast to the fire service domain, in terms of roadside assistance TEW has never undertaken any studies or investigations related to optimising technical working procedures, using methods of

knowledge management or computer-based support. Therefore, the focus of this study is put on eliciting new and suitable knowledge about TEW. Furthermore, TEW has never considered the use of decision support systems for mechanics use during their work. Consequently, this study has to cope with uncovering a new area for elaborating user needs.

Available documentation used by TEW on a daily basis is analysed in order to gain an understanding of their current working practices. These include administrative activities, technical procedures, and mobile working. TEW is described below in order to gain an appreciation of their services and objectives. Then the available documentation is described enabling us to draw conclusions concerning their current working practices and potential user needs within the AMIRA focus.

6.1.1   Transport Engineering Workshop

Transport Engineering Workshops (TEW) is a section within the Technical Services department of the *West Midlands Fire and Civil Defence Authority* (WMFCDA) [13]. The operational arm of WMFCDA is *West Midlands Fire Service* (WMFS), headquartered in the centre of Birmingham (the UK's second city) and operating from 41 sites in the West Midlands area with an operational fire-fighting fleet of over 100 vehicles. TEW have complete responsibility for the whole WMFS vehicle fleet, which includes all the incident vehicles such as fire engines, back-up and support vehicles, command control vehicles, as well as 'regular' commercial vehicles such as cars and vans. TEW also have their own fleet of service vehicles, which are kitted out as mobile 'mini' workshops. TEW are responsible for each vehicle and its content (e.g. turntables, hose equipment etc.). This means that a fire engine (for example) comprises components from far more suppliers than would an ordinary commercial truck. TEW provide service, maintenance, repair, modifications, as well as customer support and administrative services for the WMFS and TEW fleets. TEW also fulfils the role of engineering advisor to the Chief Fire Officer on such matters as specifications, development, modifications and disposal of vehicles and equipment.

TEW activities are supported by four key groups:

- The Maintenance and Repair Workshop
- The Stores Department
- The Administrative Department
- The Technical Support Stuff

The Maintenance and Repair Workshop provide daily routine maintenance and repair to all Fire Service vehicles and equipment - both scheduled and unscheduled repairs, either on-site or at customer's premises. In this context, 'customers' are the 41 WMFS fire stations. A total support package in the form of a 24-hour, 365 days per year mobile repair and recovery service is provided. TEW are responsible for all fire engines, ancillary equipment such as back-up support vehicles, and the fleet of service vehicles, which are kitted pout as mobile 'mini' workshops.

The Stores Department provides purchasing and supply services for the maintenance and repair workshop, as well as consumable items to all Fire Service customers for vehicle and equipment maintenance.

The Administrative Department provide the workshops and customers with a complete vehicle and equipment recording and costings facility together with other transport related activities.

The Technical Support Stuff provides engineering skills and information to customers related to the maintenance of vehicles and equipment to an agreed standard and support for the ongoing development of standards and specifications.

The West Midlands Fire and Civil Defence Authority also promote a Total Quality Initiative as a basis for its operations within TEW. This complements a quality management system and makes every individual responsible for the quality of his or her contribution.

In terms of WMFCDA TEW policy, this means the provision of the highest standard of quality service at the most efficient cost to achieve customer satisfaction, TEW have seven main objectives:

- Maintain and operate a quality system within the requirements of ISO 9001:2000.

- Monitor, measure and control the quality system to improve effectiveness.

- Identify and meet customer requirements, and fulfil these needs within the customers' objectives.

- Maintain continual improvements in TEW's operational activities.

- Ensure all staff is aware of their responsibilities and comply with the requirements of the documented processes and procedures relevant to their job.

- Use suitably qualified, skilled and experienced personnel and approved working practices.

- Develop employee skills, qualifications and experience through TEW's ongoing training policy.

6.1.2 Existing Knowledge Bases

Among other things the *Quality Management System* (QMS) applied in the workshop documents TEW processes, procedures, flowcharts, and quality procedures. In particular, the QMS documentation provides details which are needed to operate, to control and to improve processes. Additionally the owners and operators of all processes are identified along with the customers.

TEW distinguishes between quality manuals, process manuals, and vehicle manuals. For example, the quality manuals specify human responsibilities and how to keep adequate quality during work. Both the process manuals and the vehicle manuals are described in more detail in the following sections.

6.1.2.1 Process Manuals

The process manuals consist of process descriptions, e.g. about quality procedures, procurement processes, workshop processes, and monitor/review processes. Hence, the process manuals do not contain work instructions, e.g. how to solve a technical problem, but they specify the organisational way how a task in workshop has to be carried out. In the scope of the presented study, the main focus is put on workshop processes because they describe the mechanics' workshop activities including mobile working, which is in focus of the presented study.

The descriptions of workshop processes specify organisational processes that can occur during work in the workshop. For instance, how to operate with Job Cards that are used to capture details of jobs is described as well as how to handle mobile service vans or contaminated fuel.

The process manuals are organised in the same manner: purpose, scope, definitions, references, and the topic itself, e.g. Job Cards. Usually, a flowchart is assigned to a process manual and gives an overview about the procedure.

The handling of the Job Cards plays an important role within TEW because job cards initiate a task and capture details about a job. They are used as descriptions of the problem and what is needed to effect repair, as well as documenting how it was repaired and the time taken to do so. Hence, the job cards act as a protocol for the repairs. As the Job Cards represent such an important aspect of TEW operation, the life-cycle of a Job Card is described in further detail below. .

First, incoming repairs or tasks are entered on the computer system either by the customer (the fire fighter driving a fire engine for example), or by the workshop at the customer's request. Second, the vehicle service receptionist is responsible for scheduling the work in the computer system. This is done at least once each working day, with the receptionist assessing the work to be done. Several possibilities can be triggered by the receptionist. A vehicle can be called into the workshop or a decision made to attend to the vehicle on-location using one of the service vans. Another possible action is to consider the defect as minor and allocate it to the next scheduled service. Furthermore, defects can be considered as warranties or insurance claims or as non-urgent defects which cannot be allocated to the next scheduled service.

Job Cards fall into several categories:

- Service van Job Cards – scheduled and unscheduled work carried out off-site;

- In-house Job Cards – scheduled and unscheduled work carried out in-house;

- Tyres/wheels Job Cards – completed for all requests for tyre/wheel repairs on or off-site, during or out of working hours

- Standby workshop mechanics Job Cards – completed as and when work is carried out by the standby workshop mechanic

- Contractor Job Cards – work carried out by outside contractors including insurance repairs and warranty vehicle/equipment will be booked out to outside contractor via the vehicle service receptionist

Furthermore, the receptionist is responsible for allocating Job Cards to the workshop mechanics. The in-house Job Cards are passed to workshop mechanics. The tyres/wheel Job Cards are passed to the TEW stores where they are arranged for the necessary work to be carried out, e.g. for rectification or collection of loose wheels and tyres. Job Cards for assembly kits are passed to the stores who will record all the necessary parts on the Job Cards and pass it back to the workshop supervisor for action by a workshop mechanic. In all cases, Job Cards will be assigned to the 'awaiting labour' holding bin until a workshop mechanic becomes available. All completed Job Cards are passed to the workshop supervisor who checks for the necessary documentation, authorisation and completion. After that he codes the Job Cards as per the job card task codebook, signs and dates all Job Cards which are then be passed to the administration office.

The completed Job Cards are manually entered into the computer system. Due to assigned to a pre-defined fault codes the repairs or defect can be described unambiguously. Beyond the code assignments, the mechanic describes the issues in his/her own words and it is also possible to enter additional information. Consequently, an exhaustive report is captured in the computer system on the work which is done in TEW.

Several TEW organisational processes are illustrated by flowcharts that represent the flow of work to the corresponding task. Concerning the mobile road assistance a flowchart shows the sequence of the call of mobile workers as depicted in Figure 17.
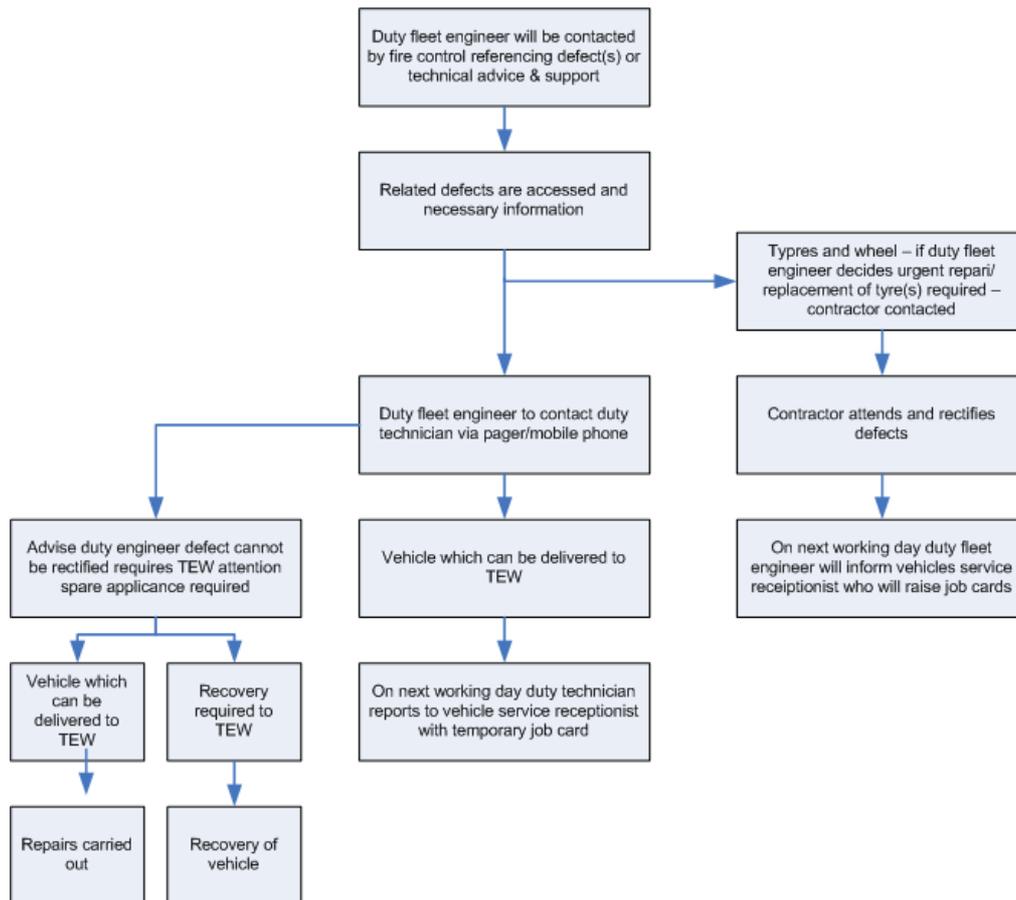
Figure 17: Flowchart of Mobile Worker Call Out

Here, the procedure is described, who decides when a repair is done remotely, and how it is done. Fire control contacts the duty fleet engineer and specifies the defects or the need for technical support. At this level, the calls that relate to tyres and/or wheels can be selected and treated separately. After reviewing the other outstanding calls the duty fleet engineer will contact the duty mechanic via a pager or mobile phone and the decision made as to whether the vehicle should be brought into the TEW workshop or not. When repairing the vehicle at the TEW workshop, the mechanic reports on the next working day; when repairing remotely the mechanic conducts the recovery.

6.1.2.2   Vehicle Manuals

A reference library of vehicle/equipment manuals that can be utilised for looking up technical details are held at TEW. . Maintenance methods are defined in the quality management system. These manuals are available in two locations in the workshop. One copy exists in the principle workshop mechanic's office and a second one is available in the electricians shop. The manuals are controlled by a master index, located in the principle workshop mechanic's office which references them by shelf number, issue status and date.

Updates are received in one of two ways: either new pages/sections are provided by manufacturers to replace existing ones, or service bulletins are issued which must be read in conjunctions with the existing manuals.

For example, the manual of Dennis vehicles (the main make of Fire Engines to WMFCDA) are available electronically and comprise an operator handbook and information related to services and parts of the Dennis Sabre series. The operator handbook is based on the chassis and original equipment fitted at the Dennis Fire factory. The purpose of this handbook is to provide drivers with information to help them in operating their vehicles safely and efficiently; it is a reference manual

which presents illustrations and descriptions on how to handle particular functionalities. Furthermore, the handbook consists of detailed specifications, e.g. lubrication chart.

Beyond health and safety notes, the service manuals consist of descriptions of all services that are essential to the corresponding vehicle. For example, servicing is represented in detail, e.g. when a specific check has to be carried out and how it has to be done. All information needed for conducting servicing is captured by the service manuals.

The parts manual is a collection of detailed parts descriptions. Parts are illustrated by pictures, and annotations give further information about parts constructions. The annotations provide the part manual users with an understanding of these pictures as depicted in Figure 18 and Figure 19.
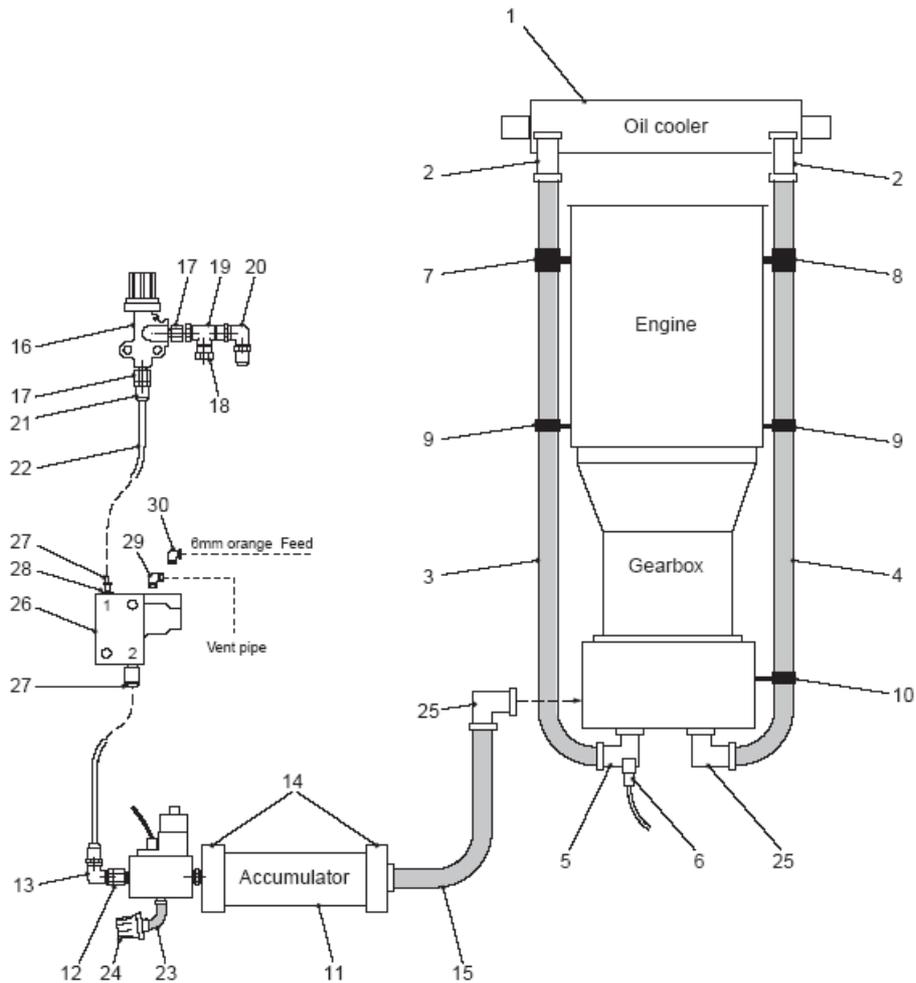
Figure 18: Illustration of Gearbox

ITEM NO	DESCRIPTION	NO USED	PART NO	REMARKS
	Oil filter - internal	1	658544-2	
1	Transmission oil cooler - see Cooling section 5			
2	Adaptor - in oil cooler	2	655057	
	Dowty washer - in oil cooler	2	655058	
	Adaptor - in oil cooler	2	659855	GB1208J, K
	Dowty washer - in oil cooler	2	659856	GB1208J, K
3	Hose assembly - gearbox to cooler	1	269075	
4	Hose assembly - cooler to gearbox	1	269076	
5	Elbow - gearbox left side	1	269787	
6	Temperature sensor	1	658054	
	Dowty washer - temperature sensor to elbow	1	603676	
7	Support bracket - front LH	1	267739	
8	Support bracket - front RH	1	267719	
9	Support bracket - mid support	2	420571	
10	Bracket, cooler hose - RH side of gearbox	1	268089	
	Bracket, oil cooler pipe - gearbox lug LH side	1	267850	
	Backing washer	1	211401	
11	Accumulator - including solenoid	1	658610-2	
12	Adapter, ¾ NPTF M16 - to accumulator	1	657876	
13	Elbow - accumulator	1	654919-3	
☞ 13	Elbow - in accumulator	1-3	602000-14	GB1208D, H, K
14	Bracket - accumulator mounting	1	265539	
15	Hose assembly - accumulator to gearbox	1	269077	
16	Valve - pressure protection	1	612049	
	Spacer - between valve and outrigger	1	400622-31	
17	Reducer - valve inlet /outlet	2	654927-3	
18	Plug M16 - valve inlet tee	1	612747	
☞	O ring	1	651571-4	
19	Tee piece - valve inlet	1	654923-1	
20	Elbow 90° - valve inlet	1	654919-3	
☞ 21	Connector - straight - 12mm pipe	1-4	654921-4	
22	Pipe, nylon 12mm green	3m	654749	
23	Elbow - hose to solenoid	1	267923	
	Hose clip	2	656818-2	
24	Silencer	1	656589	
25	Elbow - gearbox right side & accumulator hose	2	656631-8	
	Pressure switch - 2 psi	1	657410	Retarder 1st stage
	Pressure switch - 7 psi	1	657411	Retarder 2nd stage
	Pressure switch - 10 psi	1	657412	Retarder 3rd stage
	Connector kit - 3 way	1	656856	Retarder interface
	Harness - retarder extension	1	267173	Retarder interface
	Resistance module, 3 step	1	655326-5	
	O-ring - 50mm	2	656272	GB1208D, H

Figure 19: Annotations to the Gearbox

The content representations of the vehicle manuals consist of many pictures so that they are essential for users in understanding the manual contents.

6.2 INTERVIEWS AND QUESTIONNAIRES

Interviews are conducted with several persons who work at TEW, and who can be associated with different profiles. These profiles were elaborated prior to the interviews in order to cover as wide a range of different TEW employees and to ensure a representative selection. The following profiles are pointed out:

- Novice/inexperienced mechanic
- Mechanic who has been working at TEW for just a few years
- Mechanic who has been working at TEW for many years
- Mechanic who has experience in companies other than TEW
- Persons who coordinate mechanics and/or receives the customer calls

For selection of the interviewees the profiles are taken into account. At least one person represents one profile.

6.2.1 Questionnaires

In preparing interviews, a questionnaire was developed and tailored in order to ascertain general knowledge about TEW and information demands that can be potentially provided by the AMIRA vision. Therefore, the questionnaire was structured in the following sections:

- General questions
- Services
- Mobile working
- Customers
- Information sources
- Information support
- Notes
- Training facilities
- AMIRA vision

The complete questionnaire used for interviews is presented in Annex 3.

The section of general questions refers to eliciting information about the department, about personnel, and about positions or responsibilities of interviewees. In particular, the interviewees gave their views on TEW, its vision and goals. Information concerning the classification into the profiles is elicited and different opinions based on different experiences became obvious. Prepared questions referred to team working among mechanics and their team structure, which enabled the organisational structure of TEW can become apparent.

The services section focus on eliciting all services provided by TEW. Additionally, the corresponding questions were tailored to uncover current working practices, including both technical/mechanical and organisational work procedures; collaboration between mechanics or mechanics and non-technical staff were discussed. Details of the types of vehicles/equipment that are supported by the workshop were also requested, in order to obtain an overview about the range of objects that are repaired by TEW.

The next group of questions referred to mobile working. Characteristics were pointed out that decided when a job would be done remotely by mobile workers. In particular, the mobile working procedures had to be described by interviewees.

The next questions addressed TEW customers and TEW information sources. Interviewees were requested to itemise all information sources available in workshop.

The information support section refers to information support within the workshop. The interviewees were requested to describe if or when they had information demands during work and how they coped with these demands.

The next questions addressed knowledge capture and documentation. Here, the interviewees were asked to describe when (or if) they make notes of their work for, e.g., sharing their experiences with their colleagues.

The response on training facilities questions provided information about the skills and knowledge of an interviewee.

Finally, the AMIRA vision was addressed in the interview in order to gather the interviewees' opinions about potential decision support approaches. Here, the ideas of AMIRA vision are discussed.

The questionnaire for the last profile was prepared similarly to the mechanics' questionnaire but some topics were prioritised differently in the interview sessions, such as the schedule of mobile and non-mobile mechanics, documentation facilities, and the organisational structure of TEW. The AMIRA vision was discussed with the representatives of the last profile and they estimated the possible advantages of AMIRA related to TEW.

6.2.2 Interviews

This section focuses results that were achieved through interviews. All presented information is based on conversations with the interviewees. Here, the elicited information is presented without showing any conclusions; just facts as stated by the interviewees.
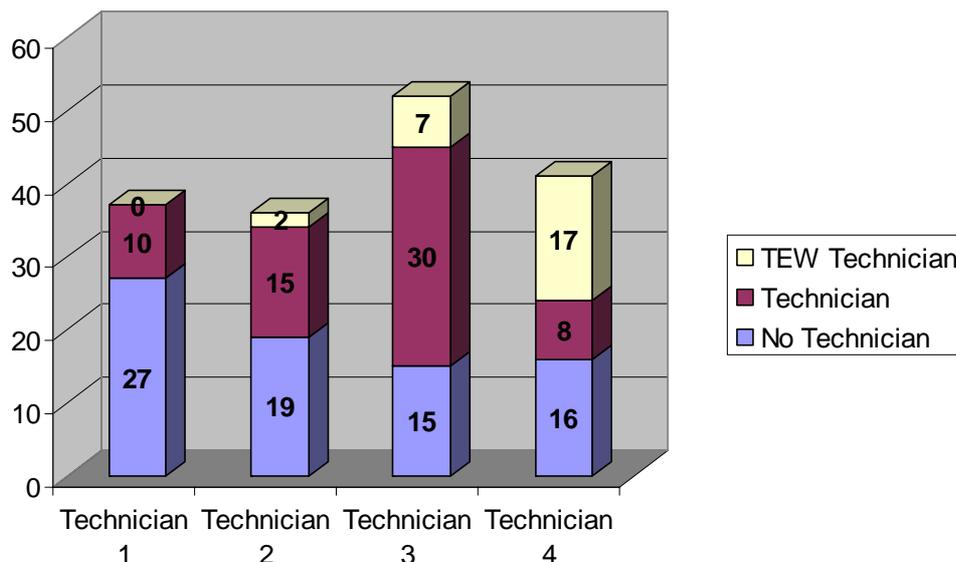
Figure 20: Profile Representatives and their Technical Experiences (in years)

The first interviews are conducted with four mechanics. One mechanic represents the corresponding profile as described above depending on his/her experience as mechanic as shown in Figure 20. For example, the first mechanic is 37 years old, he has experiences as mechanic for 10 years, and he is a new TEW employee.

As representatives of the last profile three persons (a receptionist, a supervisor, and a workshop manager) are selected for giving information about TEW background and administration procedures at the workshop.

6.2.2.1 *Results - General*

The quality of interviewee answers depends on the length of time as employee in TEW. The longer an employee works in TEW the more he or she can give detailed information. It is also allowed to

reject questions when no answer was known, which was often the case with the newer TEW employee.

6.2.2.2 Mechanic Interview Results

In order to keep up the structure of the questionnaire the results of the mechanic interviews are presented in consideration of general information, services, mobile working, customers, information sources, information support, notes, training facilities, and AMIRA vision.

6.2.2.2.1 General Information

TEW consist of about 20 vehicle mechanics and 10 persons who are working in the offices or in management. All mechanics are working at the same level; differences are only made if they have been less than 6 months with TEW, because then they are not fully trained in undertaking their jobs. Some mechanics show respect toward other mechanics because of their age, experience, and knowledge, so that tit is possible to determine implicit differences between mechanics. The mechanic's job is very diverse as it covers different types of vehicle and ancillary equipment. Mechanics report to the workshop foreman/workshop supervisor but no one reports to the mechanics, except, perhaps, apprentices.

All mechanics interviewed are vehicle or workshop mechanics and have previous experience as mechanics in other companies that work with heavy trucks and/or electrics. There are some mechanics who started at TEW straight from school. . In general, the mechanics' job responsibilities cover inspections, services, repairs, standards, safety requirements and apprentices. Furthermore, vehicle mechanics have to ensure that the required job is completed and carried out correctly and on time.

The interviewees described the goals of TEW as supporting the customers (Fire Stations) and keeping the vehicles legally and safely and working as best as they can. Areas of expertise in their department include repairs and maintenance of vehicles, bodywork, and legal regulations. Their own personal goals are to gain experience or knowledge as mechanics, to progress through promotions to achieve a higher position in the brigade, and to work at the highest standards as they can. In particular, standards play a crucial role in TEW, one point which is different to other workshops; another is that TEW mechanics have a wider range to repairs because of the fire equipment housed in the vehicles. Furthermore, TEW emphasises more safety and clean environments than other workshops.

6.2.2.2.2 Services

During the four interviews the following services undertaken by TEW were highlighted:

- Inspections/Ministry of Transport (MOT) inspections
- Ad hoc repairs/break downs
- Repairing defects
- Routine maintenances
- Mobile assistance
- Equipment repairs
- Body work
- Modifications
- Damages

For the ad hoc repairs or breakdowns TEW provides a 24-hour-service. Other repairs are mostly undertaken in the workshop. Just three mobile vans are available at TEW: one of the three is the call-out van.

The mechanics are not specialist experts but can be considered as general all-rounders. Because the undertaken different types of services and different equipment repairs, certain mechanics

develop a level of expertise that gives them more knowledge about special issues than their colleagues. Hence, mechanics know whom they have to ask concerning a special problem. For instance, some mechanics have specialist knowledge in welding, water pumps, hydraulic platforms or electronic systems.

The different types of vehicles that are maintained at TEW include: appliances/fire engines (Dennis), Mercedes sprinter vans, Volvo trucks, MAN trucks, Transits, Mercedes vita, vans, boats, Lorries, trailers, caravans, and prime movers.

Equipment that is serviced, maintained, or repaired at the workshop includes: Holmatro equipment, engines, axes, breaks, water pumps, portable pumps, generators, fans, electrical systems, body works, and hydraulic platforms.

The job procedure is always the same irrespective of the type of job, equipment or vehicle. Mechanics get a Job Card that specifies the vehicle or equipment to handle and the respective problem description. Therefore, Job Cards capture symptoms including specifics such as engine smoke, air leak or less specific comments such as 'it does not operate correctly'. During the job, mechanics have to describe briefly what they do and how they clear the faults. Information such as job number, when it came in, type of service, list of defects, outstanding defects, and any special requests from the customer is annotated. These descriptions can be used as a guide to what mechanics have done and why they needed the specified time. There is an additional service sheet that says what is needed for carrying out the job. Consequently, Job Cards can be up to four pages long as they capture a lot of information. After the job, mechanics return the Job Cards to the office and get a new one as next job.

In a situation where fire engine defects cannot be fixed, a reserve fire engine is made available. All equipment is transferred from the defective vehicle to the reserve vehicle. Sometimes the reserve is too small and some equipment has to be left at workshop.

When uncovering a defect that is still covered by warranty on vehicles or equipment, mechanics report to the office and a manufacturer's mechanic comes to the workshop to effect the repair. This happens, for example, when certain engine faults are detected.

Collaboration between the mechanics was identified by the interviewees. Large jobs or time-critical jobs are undertaken by more than one mechanic, so that working in pairs is sometimes usual. Jobs can be handed over from one mechanic to another at the end of a shift time, and then all information is passed on to ensure seamless continuous operation of the work in hand. Interviewees also pointed out collaboration in terms of knowledge sharing, when information or knowledge is passed on to other *colleagues. Mobile* Working

The workshop provides road-side assistance for the brigade. It differentiates between mobile working and mobile vans. Two mobile vans are used for daily mobile working, and can be called out at any time during the day. One mobile van, the call-out van, is provided with more equipment and is available 24 hours a day. Mobile mechanics drive the vans themselves.

Mechanics can work remotely after they have been at TEW for at least six months.   No extra pay is paid for mobile working. Usually, mechanics change their mobile assignments very often with other colleagues because not all mechanics like to work remotely. Because there is no differentiation between mechanics the workshop management accept the changing of these remote jobs.

Some of the interviewees do not operate as mobile workers very often. Consequently, they gave descriptions of mobile working that were not based on much experience. They described mobile work as mostly consisting of safety inspections, MOT inspections, and replacements. With respect to the latter issue, the standard required by government is very high; defect parts are replaced at once, even when the defect can be considered as very minor.

Usually, mobile workers carry out minor jobs and they are responsible for replacements, e.g. changing blue lights, seatbelts or parts of door locks. The main reason for sending mobile workers is saving the brigade time.

6.2.2.2.3 Customers

As a sub-organisation of WMFCDA, TEW operates solely for the West Midlands Fire Service. The customers are the brigade's 40 fire stations; no other institutions or private persons are supported at the present time. However, it should be noted that due to the regionalisation programme that is being put in place for UK fire services, some brigades will merge to be considered as a regional entity. In this case, it can be envisaged that TEW would assume responsibility for the repair, service and maintenance of other brigade vehicles and equipment in the new region.

6.2.2.2.4 Information Sources

The interviewees were requested to itemise all the information sources that are available at TEW:

- Work instructions
- Decision Support based on manuals
- Manuals – instructions for all vehicles
- Parts manuals
- Support from experts (e.g. telephone)
- Colleagues
- External experts (manufacturer)
- Technical bulletins
- Intranet

For example, the manuals and paper documentations contain information about policies, risk assessments, calibrations, tool inventories, and workshop equipments. From the mechanics' point of view, the information provided is sufficient for carrying out jobs in TEW. Furthermore, the mechanics confirmed that the manuals were very reliable and up to date because new updates are frequently received from the manufacturers.

Manuals etc. are not kept near to where the mechanics are working but in the management office on the second floor where a library is located. These documents are not used very often; apparently newly employed mechanics use it very rarely as well. Predominantly, the mechanics work with recurring problems and it is quicker to ask colleagues. The Intranet that is particular to the brigade is available but cannot be utilised during work because it does not contain technical data, just general information related to the brigade.

When undertaking diagnostics a laptop computer can be used, which is available in the technical office. By using this laptop a mechanic is able to readout the memory banks of engines, e.g. specific fault codes. Hence, mechanics get to know what the problem is and get solutions for the defects. Additionally, he/she can access the mainframe to look at all available information about the faults. However, these fault codes are not the same as the fault codes used in the internal computer system which coordinates and manages the Job Cards.

6.2.2.2.5 Information Support

In the workshop it is usual for colleagues to work together, so the interviewees referred to a team. Usually, support can be requested from colleagues that can concern physical help to carry something or technical aspects. If mechanics encounter a rare or new problem, they ask colleagues for solutions or for work instructions. For instance, problems can arise concerning gearboxes or ladders; mechanics who have little experiences with repairing fire engines may need support in water pump test or inspection procedures concerning fire equipment. The interviewees estimated that mechanics look for information once or twice a month. Then they mainly look for settings, clearances, and adjustments.

Conversation among mechanics is very important because everybody works differently, so that they can learn from each other. Technical advice is also requested when mechanics did similar jobs long ago but the work instructions have been forgotten. Beyond asking colleagues for

information, mechanics get the opportunity to learn from the manufacturer's mechanics when they come into the workshop to rectify specific problems, or when new equipment is being serviced.

Furthermore, the mobile mechanics can use manuals when encountering rare and unknown problems. Mobile mechanics utilise mobile phones for calling the workshop for help, in particular to ask the foreman for advice. Also to determine if a defective part should be replaced. Based on experience, these options of information support work very well for handling problems that occur outside the workshop.

For example, because of a lack of knowledge about the electric system, a mobile mechanic requests information support when repairing an hydraulic platform. He can use the books in the mobile vans or can look in the reference proceedings to get instructions. In contrast, another interviewee described that he would first call the electrician at TEW to get practicable information. To get more detailed information, he would then look in manuals. It was noted that it is easier and quicker for mobile mechanics to call up someone in the workshop than to use manuals for getting information. Usually, the workshop employees will have the time to answer the query.

As a mechanic's vision of information support, the interviewees described two ideas. First, a computer-based support is intended that avoid paperwork and provided easier access to data. For example, the mechanic utilise a laptop for logging into a system that provides the access to the job schedule, jobs, their descriptions, and all details that are necessary for carrying out the jobs.

The second idea is the provision of computerised checklists. For some routine jobs, e.g. servicing and maintenances, mechanics could have checklists that they have to go though and to check off the single items. The purposes of these checklists are to assure that all items are checked and to keep a high quality.

6.2.2.2.6 Notes

Usually, mechanics make personal notes about problems or jobs carried out in workshop. These notes are kept in their toolbox and are only for personal use. These notes can be seen as **lessons learnt** from the mechanics' work.

It is not usual to share these personal notes, apart from when they are working with other persons on the same job. In terms of lessons learnt nothing is officially supported or initiated by the workshop management or mechanics.

6.2.2.2.7 Training Facilities

All mechanics have to participate in training courses, particularly, when the brigade get a new vehicle. Each mechanic attends training courses about twice a year or more for learning more about safety and about their job procedures.

For example, the following training courses are usual in TEW:

- Vehicle inspection courses
- Holmatro courses
- Courses for new engines
- Hydraulic platform courses

6.2.2.3 Management Interview Results

The non-technical profile of a vehicle service receptionist, the principle workshop mechanic, and the workshop manager were selected in order to enable the elicitation of knowledge about schedule procedures, management aspects, and estimations of the AMIRA vision.

The knowledge of the receptionist is based on 2.5 years in the workshop, where she is responsible for handling incoming telephone calls, maintaining job cards, monitoring the workshop with regard to vehicles coming-in, monitoring the service vans, and the schedules for the service vans. Her job goal is to ensure services for customers as efficiently as possible. The experiences of the principle workshop mechanic traces back to the fact that he has been working for TEW for 2.5 years and

that he has very considerable prior experience as a workshop manager. The workshop manager also has very considerable experiences that he has gained over many years.

In order to avoid the replication of results that are described in the last section, here only new facts, opinions, and statements are represented. Known results are only reiterated when contributing to a better understanding.

6.2.2.3.1 General Information

From the interviewees' point of view, the goal of TEW is to increase the performance that indicates all forms of quality control checks including monitoring processes and improvement processes. In fact, TEW works for the brigade in order to provide mechanical services, mobile services are included in TEW responsibilities to save the brigade money. The areas of expertise provided by TEW are the resources of qualified vehicle mechanics for mechanical, electrical, and body repairs.

6.2.2.3.2 Services

The workshop attends to about 100 appliances and 110 other vehicles. The vehicles that are regularly in the workshop for maintenance purposes are pump rescue ladders, hydraulic platforms, life vehicle, specialist fire engineer equipment, and general issues. The services provided by TEW can be distinguished in servicing, inspections, bodywork, and defects. The corresponding percentages estimated by the interviewees are illustrated in Figure 21.
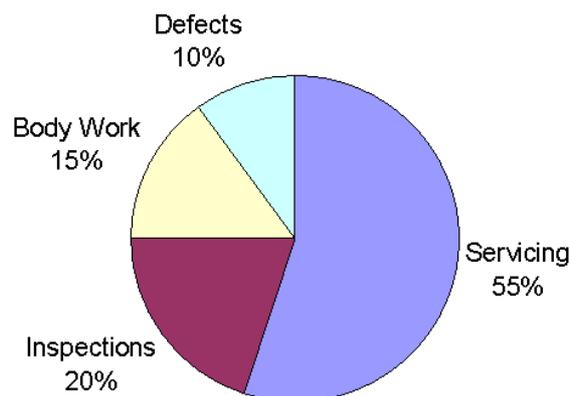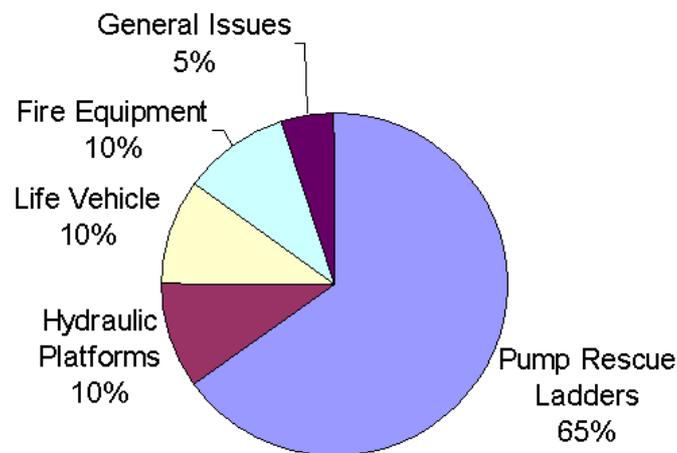

Figure 21: Kinds of Services in the Workshop

According to Figure 21 the main jobs are servicing jobs. After that, inspections are carried out mostly because inspections are prescribed by regulations for assuring safety and quality. The following inspections are carried out frequently:

- Every six weeks: service inspection
- Every twelve weeks: A category services
- Every 6 months: B category service
- Every 12 months: C category service

Defects that are repaired by the mechanics are mostly minor repairs. The interviewees estimated the percentage of minor repairs as about 60%. Mostly repairs on pump rescue ladders as depicted in Figure 22. Examples for equipment repairs are tyre compression, searchlights, extension cable, and light portable pumps.

General Issues
5%

Fire Equipment
10%

Life Vehicle
10%

Hydraulic
Platforms
10%

Pump Rescue
Ladders
65%

Figure 22: Kinds of Repairs in the Workshop

From the receptionist perspective the Job Card procedure is carried out as follows. The customer or brigade request comes in by telephone or by a special intranet portal where customers can enter the vehicle or equipment defects themselves. The receptionist accepts the calls and estimates what to do. For further queries and related communication the receptionist utilises email or telephone. After having finished specific jobs the mechanics come to the office to return the Job Cards and the used replacement parts are booked. Then the receptionist can finished the job as well. In contrast the mobile mechanics finish their jobs verbally by letting the station know that the job is completed.

One mechanic carries out up to 10 services per day, which have to be considered during scheduling the mechanics. The office usually does the schedules of mechanics for 4 months in advance. In contrast to that, the mobile mechanic is scheduled in periods of one month; the mechanic who drives the call-out van is scheduled for one week. In urgent cases the receptionist calls mobile mechanics to give them information about time-critical jobs that they have to carry out.

The receptionist schedules the service vans independently of the mechanics who drive these vans. According to mechanics' statement, all mechanics are on the same level when they have been working for TEW for six months - no difference is made.

How many vehicles are regular in the workshop depends on how many mechanics are available. On average, three vehicles are in workshop for servicing and five with defect repairs.

6.2.2.3.3 Mobile Working

By accepting the telephone call from the customer the receptionist can assess the defect or symptoms, which she also notes on the Job Card. Estimations are based on her experiences that she has gained during her work in the workshop. She is able to decide if the vehicle has to be brought into the workshop, depending on what has to be done, or she triggers a mobile mechanic to take the job over, e.g. the mobile mechanic is in the area already and it is not an effort to drive to the defective vehicle. Furthermore, it depends on the equipment in the mobile van. If the mobile mechanic has the requested replacements in his van then he can carry out the job remotely, otherwise the vehicle has to be brought to the workshop and the problem rectified there.

6.2.2.3.4 Information Sources

Quality manuals specify the organisational information about TEW and all the functionalities of TEW staff.

The receptionist can also provide a kind of mediation when being called by mobile mechanic and asked for assistance. She can then mediate someone who has the level of competency to provide the necessary information support for the mobile mechanic.

6.2.2.3.5 Training Facilities

Mechanics who come to TEW get a lot of training facilities and courses in order to get the same knowledge as the other TEW mechanics. Furthermore, training courses are conducted when new vehicles come to the brigade's fleet. Otherwise mechanics acquire the knowledge by using manuals or by communicating with colleagues.

6.2.2.4 AMIRA Vision

Both the mechanics and the non-technical staff were presented with the AMIRA vision. They were asked to think about this vision before giving a first evaluation from their point of view. Here, just assumptions and broad assessments were achieved.

During the interviews the AMIRA vision was described as support of mobile mechanics with information support during their daily work. The interviewees should imagine a mobile worker who wears a headset and who can send a speech-based request to a computer system over the microphone for getting a synthesised answer. The computer-based system searches its knowledge sources, including its case and databases and other information sources as itemised above, as well as the information on Job Cards. The common reaction on the presentation of this vision was that the idea would be very interesting and innovative. Immediately, the interviews focused on benefits of reduction of working hours and the independence of telephone support. But they also added concerns that must not be neglected. First, motor noise beside road assistance could be a concern for realising this vision because the speech recognition would only capture broken conversations. Second, situations in which mobile workers look for information and ask for help do not occur very often, so that the effort for supporting TEW mobile workers may not be cost effective.

The use of the Job Card description to solve similar problems was criticised because of the different and extensive ways the descriptions are composed by mechanics - for example, there are several alternatives as to how a comparable defect is described. Furthermore, mechanics utilise different terminologies; there is no standard format yet in how to describe and write down the Job Card data. Naturally, the mechanics write the description in their own words, so that it is sometimes difficult for their colleagues to read, particularly, for novices. Consequently, it is not sure if novices or mechanic with little experience are able to understand the written solution, in particular, the descriptions have to be interpreted and transferred sometimes.

In conversation with the interviews it was pointed out that mechanics of AA (Automobile Association) or RAC (Royal Automobile Club) - the two motoring support organisations in the UK, would be more suitable for evaluating the AMIRA vision because their working area is not limited as the TEW area is. Furthermore, the AA and the RAC provide automobile roadway repair services that deal with a wide range of breakdowns of different makes and models that are frequently not well known to their mechanics. Hence, complicated and rare problems are encountered very often during daily work in contrast to that at TEW.

TEW is ISO 9001/2000 certified. Part of this certification requires that a contingency plan is in place to assure business continuity when aspects of the business are disrupted though (say) an illness which causes many staff to be off-work at the same time - such as a 'flu epidemic. From a management perspective, three specific situations that could impact on business and that were relevant to the AMRA vision were identified:

1. A situation where there was insufficient mechanics available to handle the workload in a timely manner. In this case, free-lance mechanics, or mechanics from other sources would need to be brought into TEW for a short period of time. These mechanics are likely to be unfamiliar with some of the diverse equipment currently serviced by TEW. To assist them in getting up to speed as quickly as possible, the AMIRA system could be used to provide 'on-the-job' support.

2. The UK fire services are going through a period of restructuring, which will result in a regionalisation of fire services, reducing the overall number of services in the UK, whilst expanding the physical areas they serve. In such a situation, in-house engineering works, such as TEW, would be required to expand their operation to cover the additional resources in the extended area. As each fire service has autonomy in choosing the make etc. of vehicles it uses, this could result in TEW being in a position where its mechanics were not familiar with some of the vehicles or equipment they would be required to service. AMIRA could provide a useful 'stop gap' tool during the transition period when mechanics were required to service/repair unfamiliar equipment and vehicles.

3. In the situation identified in (2), it would be necessary for TEW to expand its operation including bringing new mechanics on board to complement the existing work-force. Here AMIRA could be used as a training tool, enabling new and/or inexperienced mechanics to get up to speed and become operational more quickly.

Discussions with the TEW Works Manager highlighted another possibility for AMIRA that he considered to be of considerable interest. This related to the use of AMIRA as part of TEW's spares holding process through stock trend analysis in order to decrease costs, through the dynamic notification of availability and recall of spare parts to persons in charge (fleet manager at TEW). The AMIRA system could provide hooks to such external systems (spare parts management system, debrief management system etc.), and could provide workflow enabling to reach these hooks. Furthermore, AMIRA could also suggest alternative options for repair.

This potential for AMIRA had not been envisaged before and could prove to be a very interesting post-project business possibility, albeit out of the scope of the contracted AMIRA project work.

6.3 REQUIREMENT ASSESSMENT

The current state of working, the information sources used by TEW employees, and the user skills are sufficiently described by the results of interviews and questionnaires (Section 6.2). Therefore, the requirement assessment focuses on describing user requirements and use cases within the TEW.

6.3.1 User Requirements

The user requirements base on the contingency plan described in Section 6.2.2.4 where a training tool is described that enable new and/or inexperienced mechanics to get up to speed and become operational more quickly. For coping with the requirement of a training tool, the first use case elaborated for the FSC is modified and adopted as described in the following section.

6.3.2 Use Cases within TEW

For providing new TEW mechanics with information the following use case is elaborated as depicted in Figure 23. New TEW mechanics can utilise the AMIRA system during their work for looking for information or for playing safe.
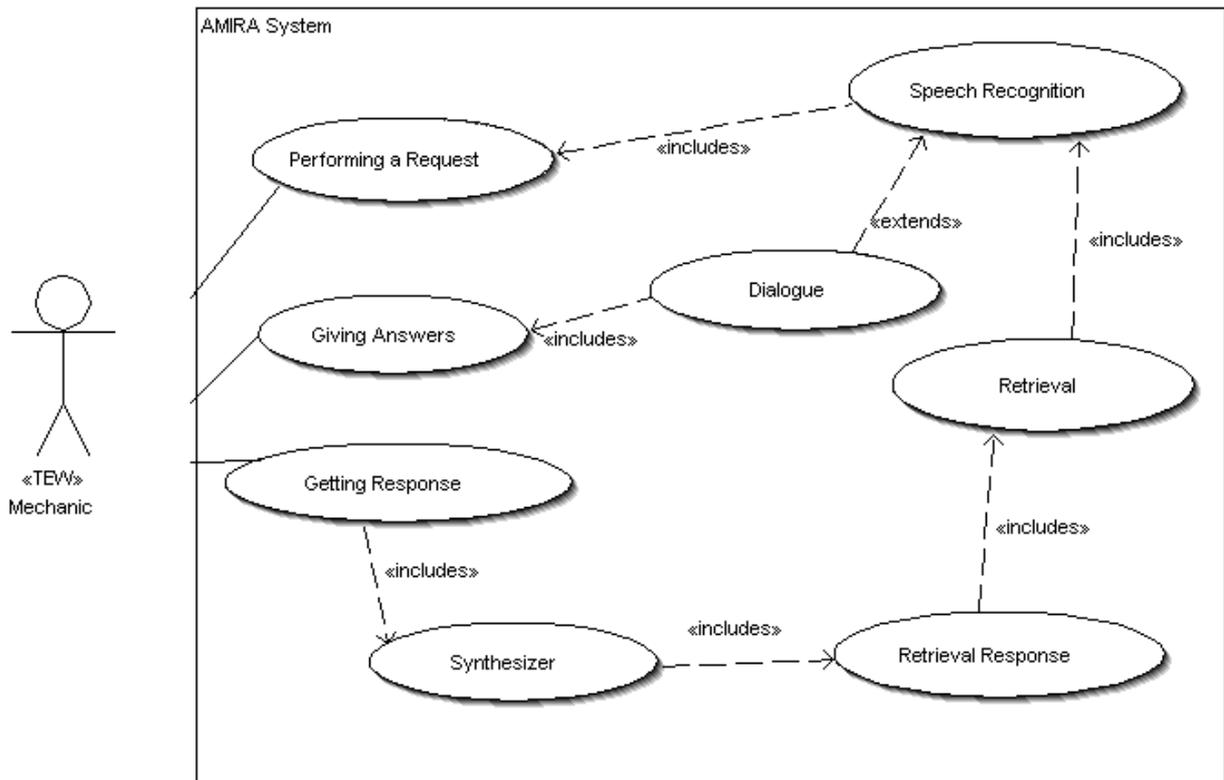
Figure 23: TEW Use Case 1

Event	Description
U1	The mechanic makes a spoken request.
S1	Speech recognition component analyses the spoken request.
S2	If necessary the dialogue component starts an interactive dialogue either to get confirmation about the analysed request or to request more information.
U2	The mechanic gives answers to this request for additional information.
S3	System routes the query to an appropriated search engine and executes a retrieval request.
S4	System gets answer from the retrieval service.
S5	The synthesizer transforms the result into natural language for the incident commander.
U3	The mechanic gets the spoken response. This response can be the final response; can contain multiple-choice options for narrowing down the result set; or contain a request for further information.

One scenario is to utilise the AMIRA system as training tools; probably new mechanics or mechanics who are at TEW for temporary work are addressed. The AMIRA system enables these mechanics to look up information during work and they can use it to be sure. For example, they do not know settings, calibrations or procedures exactly, and then they can look it up without time-consumption when asking colleagues or searching for paper information.

7 SUCCESS CRITERIA

This section presents indicators that estimate the value of the presented socio-economic study of user needs in order to assess its importance and success in the context of mobile working in time- and business-critical situations. Therefore, four success criteria are discussed that are defined in

Section 4.5. Besides achievements of the presented document possible impacts on other fields become obvious.

7.1 UTILITY

Utility denotes the acceptance on behalf of the end-users how satisfied they are with respect to developed user needs. Furthermore, utility also comprises how end-users benefit from the presented study, e.g. in form of new knowledge and added values. In that context, several points of discussion are pointed out.

Clearly, the presented study can be considered as voice of the end-users. Involved in the interviews and interrogations the end-users were able to express their positions and arguments for potential information support. Additionally, the end-users were involved in evaluation processes concerning the outcomes of the presented study, whereas they had the chance to modify requirements and to adjust user needs.

One topic of the presented study is the elaboration of current state of working that includes descriptions and characteristics of work procedures. Regarded as analysis this elaboration pointed out new awareness about the way of working that are observed and concluded externally (from the University point of view).

Based on the elaboration of current state of working the work procedures are externally analysed concerning information demands and deficiencies in information support. External analyses show different perspectives of work procedures that can be useful for end-users, e.g. reviewing current work procedures. Potential ways of improvements of current work procedures are described.

Tailored to user domains external analysis focus on potential information support and its seamlessly integration.

The presented study provides a general perspective of mobile working in time-critical and business-critical situations because of detailed list of user needs and their motivations. Hence, a broad basis for requirement assessment in time and business-critical domains can be generalised for similar services like emergency services and automobile roadway repair services.

7.2 RELEVANCE

Relevance of the socio-economic study denotes its topicality in and its benefit for the society to whom it is aimed. Further, an assessment is derived from how the study fits into the societal demands and fits into current events.

The notion of mobile workers, who have to take business- and life-critical decision on the road or emergency sites, is been redefined by the new technology, which is currently available. This study investigates and documents information needs of this mobiles workers, which makes this study a relevant reference point for projects aiming to improve the support for this kind of workers.

In the field of emergency services, this study fits very well in the global movement to provide a better emergency response by empowerment of mobile workers of emergency services. This field is currently gaining a lot of relevance, prove of it is the increasing number of project aiming to improve the emergency services mobile capabilities. For example in U.K. the "Draft Fire and Rescue National Framework: 2004/05" [2] of the Office of the Deputy Primer Minister (ODPM), state that "… for effective response the F&R services need to ensure: (a) staff are trained to professional standards, and are familiar with risks, (b) effective command and control systems are in place, (c) incident commanders have the appropriate training and experience; and (d) the right equipment is available. These building blocks are fundamental to effective operations". The incident commanders are the mobile workers aimed in this study.

At world wide level, the United Nations has global projects to improve the support for emergency mobile workers. One of the most important initiatives is "The *Tampere Convention* on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations" [12] which states the communication basis for future works on support for mobile workers in emergency services.

In this context, the current study is fully aligned with this European and global movement, providing inside view of the needs of mobile workers.

In a more general view, the relevance of this study is evident at the light of the information society. The mankind is moving towards a new kind of society: the information society, in which works, services, and life itself is been redefined every day in every sense. One of these redefinitions is the movement towards the mobile worker of the future. In this sense, this study is part of this movement and contributes with the documentations of the current state of work and the requirements of the mobile works of the emergency services and road-side services, providing a basis for the design and redefinition of this field.

7.3 ORIGINALITY

The originality of the presented study is twofold. First, the presented study integrates results from similar studies but mainly base on particular information elicited for this study itself by interviews or questionnaires. This means that the socio-economic study for user needs are not written based on literature investigations but on real experiences from domain users, first hand information.

Second, the originality results from the contents presented by the study including innovativeness, new services, and incomparability. This becomes obvious through the concluded requirements that implies an AMIRA vision of comprising the integration of heterogeneous data sources and the seamlessly integration of the information support in the working procedures through speech technology. The socio-economic study focuses on information support that provides an interface for speech recognition. Speech recognition is currently applied in upscale vehicles like Mercedes Benz vehicles. To use speech recognition for providing speech-based request stated by mobile workers is innovative because this kind of service is still under research and not yet commercially available. Conventional mobile workers support currently focuses on device handling like Personal Digital Assistances and laptops.

Furthermore, the presented study take aim at being on the state-of-the-art emphasized by the Applied Research Findings (D2.2.2) that describes the technical realisation of the user needs.

7.4 INDUSTRIAL INTERESTS

Industrial interests can be discussed both on behalf of the user domains and on behalf of the technology utilised for realisation. From the users' point of view improvements and benefits during their work procedures are taken into account.

The overall interests of the domain users are the development of information support and the alleviation of work procedures. Particularly, this includes the reduction of error-risks, cost, and time. For instance, every kind of re-processing and re-organising actions in the field means time-consumptions and more efforts, e.g. costs. Hence, the users are interested in shortening work procedures and in improving decision support. Furthermore, the end-users intend to reduce training time as the TEW want to support new technicians by reusing experiences and knowledge in daily work. Beyond that the end-users are interested in being provided with information ubiquitously because of often working remotely.

The current document presents the fundamental reasons for creating a platform that provides wireless, easy to use, intelligent, real-time diagnostic and decision support application for the mobile worker. Furthermore, access to multiple sources of information is intended which should be realised in a meaningful way via a mobile processing and communication devices. The creation of such a platform is also the business idea that is pursued by the technology partners of AMIRA. This business idea is translated in technical terms by the development a library of reusable components using search, reasoning, speech dialogue technology and collaborative working techniques. The various components do not act separately from each other. One of the key aspects lies in the development of integration methods sufficiently powerful to provide means to reconcile the incompatibilities in data types and representations between the different reasoning and search components, and to use the incomes or outcomes of the speech component.

From the business point of view, the business idea pursues the development of industry-specific, turnkey solutions that will ease and shorten implementation times and quicken return of investment. Support to customer services for complex equipment in:

- Manufacturing

- Automotive

- High-tech

- Critical incident management

For the assessment of the industrial interests of the technology partners their business goals and technical goals are presented in the following sections.

7.4.1 Kaidara

The presented study will help Kaidara to expand its target market through being able to offer unique diagnostic and decision support solutions incorporating full textual search and speech dialogue technology capabilities in its existing product range. For Kaidara, the most obvious opportunities at present are the improvement and extension of the scope of Kaidara to provide diagnostic and decision support solutions, especially into safety or business critical environments of its existing market sectors. It is unfortunately not so rare in the software industry that the delivered solutions do not match end-users requirements, capacities, organisations or business procedures. The success criteria of the study will be measured by its capacity to define clearly the end-users requirements, processes, expected gains, and possible fall-backs, so that it provides complete and consistent support for designing and implementing the specific turn-key solutions.

From the technical point of view, Kaidara aims at integrating its offer in third-party products: Search engines, IVR (interactive Vocal Recognition) systems, Speech Dialogue Systems, knowledge management suites, and CRM (Customer Relationship Management) suites. By providing a first benchmark of the proposed integration solution described in D2.2.2, the users will contribute to evaluate the capacity of the AMIRA platform to deliver useful results.

7.4.2 FAST

FAST's business interests in the presented study is to be introduced into public safety services market through development and deployment of a unique, speech-activated intelligent diagnostic and decision support platform in co-operation with Kaidara. The planned AMIRA integration of CBR, speech dialogue technology and non-structured textual data analysis in the information management framework will significantly strengthen FAST's chances to execute on the company's core strategy.

Motivated by the application domains FAST technical interest are to cope with free-text (such as situation reports) like large amounts of (historic) information, rapidly growing amounts of (new) information, and changes in vocabulary over time. Due to the scale of existing and the pace of information growth a high degree of automation is needed for systems, e.g. for obtaining highly relevant information for fire fighters in urgent situations such as handling a fire of explosive nature. If vocabularies stayed the same it would be tempting to do a one time job with manual domain modelling in order to create navigation and search possibilities, unfortunately this is labour intensive and costly since vocabularies a highly likely to be changed over time. Fortunately targeted search for mobile work can potentially be solved using the combination of technologies such as dialogue support, entity extraction, scope search and semantic search as described in D2.2.2. Furthermore, dialogue combined with search can assist the user in efficiently finding the (situation-driven) relevant information.

7.4.3 DaimlerChrysler

DaimlerChryslers business interests are to expand the functionalities and the mature of the Speech Dialogue System (SDS) and to focus on the usage of the SDS out in the field by regarding related problems. The "Linguatronic" speech system that it available in Mercedes-Benz S, E, C, and G-Class vehicles, will be extended to more models within Mercedes-Benz and to other brands

of DaimlerChrysler. DaimlerChrysler buys the actual systems from suppliers. The research done within DaimlerChrysler tailored to the presented study flows into the consumer products via an internal business model process enables the suppliers to incorporate DaimlerChrysler technology for use in their products exclusively for a negotiable time, and later to offer it to their other customers as well.

Tailored to the requirements of the presented study DaimlerChrysler focuses on hands-free access to applications based on CBR, CSCW, and search technology. New achievements and improvements in the context of AMIRA flow into the current SDS. Therefore, work will be done on making speech recognition and speech output available via small, wearable and power-economic devices. The recognition must perform sufficiently well for an SDS to work at an acceptable rate even under adverse noise conditions, as they are picked up by the microphones of these devices, and under the bandwidth conditions imposed by them. A further challenge is to make the SDS completely hands-free by introduction keyword activation. For this, the speech recogniser has to continuously monitor the utterances of the user, and activate the SDS when an activation keyword is found.

7.4.4   University of Trier

The business interest of the University of Trier is to utilise the results of the presented study for leveraging research in terms of information support for mobile workers in time- and business-critical situation. This study allows the university to base the research on realistic situations and to adapt the CSCW component to end-user needs. Furthermore, the elaborated use cases address the current state-of-the-art described in Applied Research Findings (D2.2.2). Working on state-of-the-art leads to benefits for the university in terms of future projects and works.

From the technical point of view the University of Trier focuses on improvements of the CSCW system, the *Collaborative Agent-based Knowledge Engine* (CAKE). For coping with highly flexible situations, in which e.g. the incident commanders are, elicited in this study, CAKE supports an appropriate internal representation in form of workflows. Also for meeting the manifold user requirements the University of Trier develops an advanced workflow concept that enables the explicit definitions of processes in CAKE such as those described in the use cases.

8   CURRENT WORKING PRACTICES - UPDATE

REFERENCES

[1]   CACFOA Mobile Data Study. http://www.fire-uk.org/mobdata/study/default.htm, verified on 2004-09-08.

[2]   Draft Fire and Rescue National Framework 2004/05, Office of Deputy Prime Minister, U.K. http://www.odpm.gov.uk/stellent/groups/odpm_control/documents/contentservertemplate/odpm_index.hcst?n=4917&l=3, verified on 2005-03-22.

[3]   Hampshire Fire and Rescue Service. http://www.hantsfire.gov.uk/index.html, verified on 2004-08-19.

[4]   Huws, U.: Socio-Economic Research in the Information Society: A User's Guide from the RESPECT Project. http://www.respectproject.org/guide/416guide.pdf, verified on 2004-08-03.

[5]   Huws, U.: Towards a Definition of Socio-Economic Research for the RESPECT Project. http://www.respectproject.org/genpapers/definition.pdf, verified on 2004-08-03.

[6]   Lewis, A. (Ed.): The RIMSAT Consortium: Learning from Critical Incidents. Les éditions Sapientia, 2004.

[7]   London Fire Brigade. http://www.london-fire.gov.uk/, verified on 2004-10-18.

[8]   Social Research Association: Commissioning Social Research: a Good Practice Guide, 2nd edition, revised November 2002, London

[9]   South Wales Fire and Rescue Service. http://www.southwales-fire.gov.uk/Home_page/home_frame.htm, verified on 2004-10-19.

[10]   The RESPECT Project funded by the European Commission's Information Society Technologies (IST) Programme. http://www.respectproject.org/main/index.php, verified on 2004-08-03.

[11]   The RIMSAT Project funded by the European Commission's Information Society Technologies (IST) Programme. Project Reference: IST-2000-28655. http://www.rimsat.com, verified on 2004-10-21.

[12]   The Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations, The Intergovernmental Conference on Emergency Telecommunications (ICET-98), hosted by the Government of Finland in Tampere, Finland, 16-18 June 1998. http://www.reliefweb.int/telecoms/tampere/, verified on 2005-03-22.

[13]   West Midland Fire Services. http://www.wmfs.net/home.xtml, verified on 2005-02-14.

[14]   Wikipedia – The Free Encyclopaedia. http://en.wikipedia.org/wiki/Main_Page, verified on 2004-10-04

ANNEX 1 – RIMSAT WISH LIST
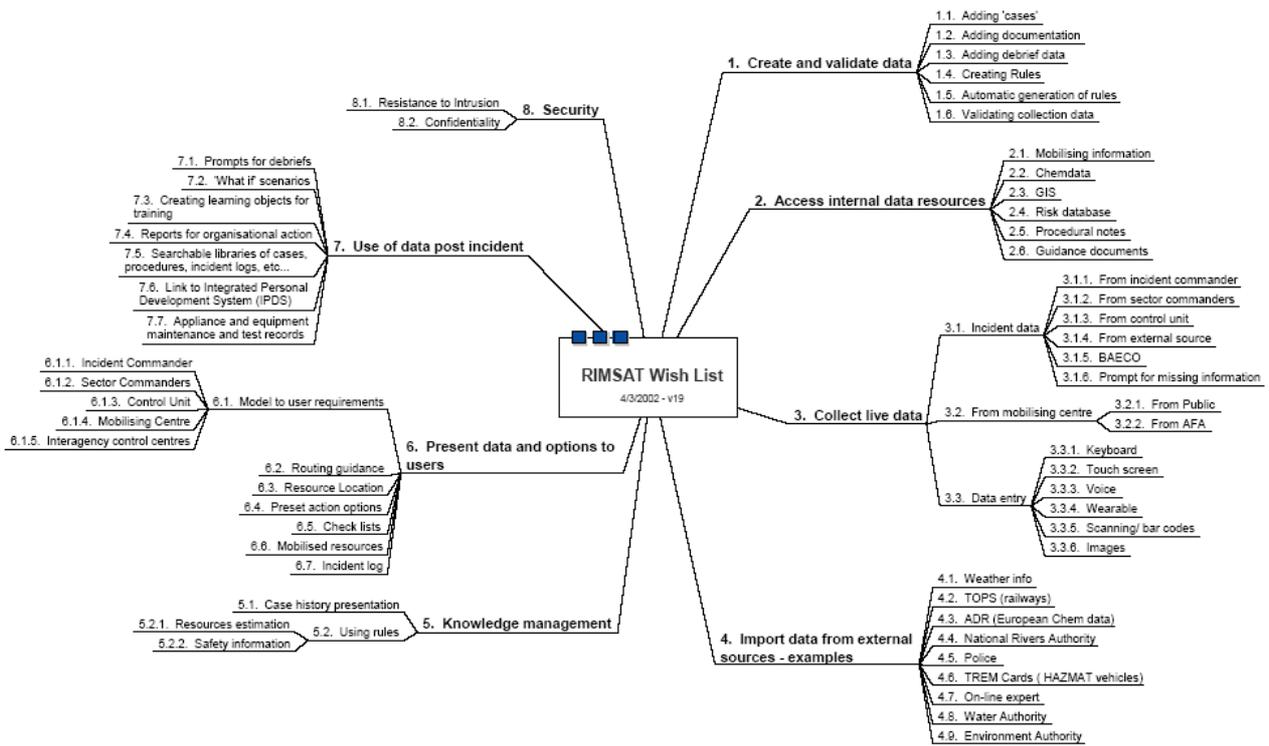
ANNEX 2 – FSC QUESTIONNAIRE

AMIRA

Advanced Multi-modal Intelligence for Remote Assistance

Fire Service College Questionnaires

General Questions   **Information Sources**   **Information Support**   **Review**   **Demographic Questions**

General Questions

1. How long do you work as incident commander?

[▼] years.

2. Have you got experiences as fire fighter etc.?

○ no ○ yes   For how many years? [▼]

3. How many fire fighters are under your control at incident (average)?

○ 1-2 ○ 3-5 ○ 6-8 ○ 9-12 ○ more than 12

4. How many appliances are involved (average)?

[▼] appliances.

5. Are the team members well known to you?

○ well known ○ most of them ○ just some of them ○ normally not

6. Do you often work together with the same team?

○ very often ○ often ○ medium ○ rarely ○ very rarely

7. Are you an expert for something special? Please give a short description!

[   ]

8. Are you a full-time fire officer/incident commander?

○ no ○ yes

Can you benefit from your main job respectively useful experiences?

○ no ○ yes

Which main job do you have?

[   ]

General Questions   **Information Sources**   **Information Support**   **Review**   **Demographic Questions**

AMIRA

Advanced Multi-modal Intelligence for Remote Assistance

Fire Service College Questionnaires

General Questions   Information Sources   Information Support   Review   Demographic Questions

Information Sources

Please use "Comments" for adding additional information or for explaining!

1. Which information sources are available in your fire service?

Fire Facts	☐		
Operational Plans	☐		
Chemical Facts	☐		
Work Instructions	☐		
Map Books	☐		
Decision Support	☐		
Hazmat Facts	☐		
Support from Control Room	☐		
Other: _____	☐	What does this source contain?	_____
Other: _____	☐	What does this source contain?	_____
Other: _____	☐	What does this source contain?	_____

Comments:

[   ]

2. Which information source is available for you at which stage?

	Time of Call	On Route	Arrival	During Incident	Handover	Review
Fire Facts	☐	☐	☐	☐	☐	☐
Operational Plans	☐	☐	☐	☐	☐	☐
Chemical Facts	☐	☐	☐	☐	☐	☐
Work Instructions	☐	☐	☐	☐	☐	☐
Map Books	☐	☐	☐	☐	☐	☐
Decision Support	☐	☐	☐	☐	☐	☐
Hazmat Facts	☐	☐	☐	☐	☐	☐
Support from Control Room	☐	☐	☐	☐	☐	☐
Other:	☐	☐	☐	☐	☐	☐
Other:	☐	☐	☐	☐	☐	☐
Other:	☐	☐	☐	☐	☐	☐

Comments:

3. Which communication devices are available in your fire brigade?

Laptop	☐
Radio	☐
Pager	☐
PDA	☐
Mobile Phone	☐
Appliance (Pager Records)	☐
Other:	☐
Other:	☐
Other:	☐

4. Where can you get which information from?

	Laptop	Radio	Pager	PDA	Mobile Phone	Colleagues	Appliance (Pager Records)
Fire Facts	☐	☐	☐	☐	☐	☐	☐
Operational Plans	☐	☐	☐	☐	☐	☐	☐
Chemical Facts	☐	☐	☐	☐	☐	☐	☐
Work Instructions	☐	☐	☐	☐	☐	☐	☐
Map Books	☐	☐	☐	☐	☐	☐	☐
Decision Support	☐	☐	☐	☐	☐	☐	☐
Hazmat Facts	☐	☐	☐	☐	☐	☐	☐
Support from Control Room	☐	☐	☐	☐	☐	☐	☐

Comments:

5. Reliability of information: How often are the information sources updated?

	every three years	every two years	every year	every few months	every few weeks	never
Fire Facts	○	○	○	○	○	○
Operational Plans	○	○	○	○	○	○
Chemical Facts	○	○	○	○	○	○
Work Instructions	○	○	○	○	○	○
Map Books	○	○	○	○	○	○
Decision Support	○	○	○	○	○	○
Hazmats Facts	○	○	○	○	○	○

Comments:

6. Which information support do you mostly utilise for getting information?

Phone	○ very often	○ often	○ occasional	○ never
Radio	○ very often	○ often	○ occasional	○ never
Fax	○ very often	○ often	○ occasional	○ never
PDA	○ very often	○ often	○ occasional	○ never
Laptop	○ very often	○ often	○ occasional	○ never
Appliance (Paper Records)	○ very often	○ often	○ occasional	○ never

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General Questions   **Information Sources**   **Information Support**   **Review**   **Demographic Questions**

Information Support

1. When do you need additional information that concerns your working procedures or decisions?

	never	once	twice	trice	four times	five times	more than five times
Time of Call	○	○	○	○	○	○	○
On Route	○	○	○	○	○	○	○
Arrival	○	○	○	○	○	○	○
During Incident	○	○	○	○	○	○	○
Handover	○	○	○	○	○	○	○

2. How often are you looking for information?

	never	once	twice	trice	four times	five times	more than five times
Time of Call	○	○	○	○	○	○	○
On Route	○	○	○	○	○	○	○
Arrival	○	○	○	○	○	○	○
During Incident	○	○	○	○	○	○	○
Handover	○	○	○	○	○	○	○

3. Please describe shortly what information do you need when you receive the call!

What information/prompts is/are important when you receiving the call?
How important, reliable or critical is this data?
Do you need this for every incident - is it variable information?

4. Please describe shortly what information do you need on route!

Do you already have questions about the incident?
When do you start to make decisions?
What knowledge/information have you used at this point?

5. Please describe shortly what information do you need when arriving the incident!

When do you have a plan?
When do you risk assess?
What do you need to know?
How do you find out?

6. Please describe shortly what information do you need during the incident!

When do you have clear objectives?
What information do you need to continue making decisions?
Is any one else involved in getting this information for you?
Do you ask external sources for information at this stage?
Can you identify significant factors that affect your decision making?

7. Please describe shortly what information do you need for handover!

How do you handover all the information you have gathered?
Are you handing over just information?
Or do you share experience/knowledge of previous experiences?

8. Do you have suggestions for future information support?

How should information support look like?
At what stage are you lacking information?
Which kind of information is missing at what time?

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Fire Service College Questionnaires

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Review related Questions

1. Are there any review processes after each operation in your fire service?

○ no ○ yes

2. Are you involved in the review processes?

○ no ○ yes

3. Is you team involved in the review processes?

○ no ○ yes

Who are the people who are exactly involved?

[   ]

4. What happens to the review reports?

☐ The reports are integrated into further working instructions.

☐ The reports are integrated into training processes.

☐ The reports are confidential.

☐ We get the reports for reading.

☐ I do not know.

5. How does your fire service acquire the review relevant knowledge?

☐ By discussions on official meetings.

☐ By protocols/reports made by involved people.

☐ By discussions with your team.

☐ Other ways: [   ]

6. Please describe shortly the review process!

[   ] How do reviews proceed?
                                            How do your record/transfer your
                                            experience or new knowledge?
                                            How carefully can you reflect on your
                                            actions and decisions?
                                            Who make use of the acquired
                                            knowledge?

7. Describe what you learn from reviews!

[   ]

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Demographic Questions

1. Age?

[▼]

2. Gender?

○ male ○ female

3. For which Fire Service do you work?

[   ]

4. Which job title do you have?

[   ]

General Questions   Information Sources   Information Support   Review   Demographic Questions

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ANNEX 3 – TEW QUESTIONNAIRE

1 General Question

Department information

Is a department organisational chart available?

Describe the mission and vision of the department, please!

Describe the goals of the department, please!

How many workers work in the department?

How many technicians work in the department?

Personal Information

What is your position in the company?

How long do you work as technician?

How long do you work for TEW?

Do you have any other positions in TEW?

Do you have any other experiences, other employers before?

Describe the area of expertise in your department, please!

Information of your position

What's you job title?

How old are you?

Gender?

What is your job goal?

What are you job responsibilities?

To whom do you report?

Who does report to you?

How many workers are in the same position as you are?

Do you need any kind of help from your colleagues sometimes?

Please describe when do you need help and what kind of help?

2 Services of your department

Please list all the services that are supported by the workshop?

General questions

Are you working for your own or as team?

How does the structure of your workshop team look like?

Do you have experts among your colleagues?

Characterise these experts, please!

Are you an expert for something special?

What kinds of jobs are done in TEW?

What kinds of vehicles do you repair in the workshop?

What kinds of equipment repairs are done in the workshop?

Please describe the job proceeding within the workshop? How a job looks like?

How is a job received – by telephone?

Who gathers information about the job?

Are technicians involved at this time?

How do you get the job instruction – in which form?

Which information do you get about this job?

Which kind of information for example?

What do you do after your job?

Are there collaboration among the technicians or between technicians and other persons?

Could novices/inexperienced user use the Code/descriptions for similar jobs – as work instructions?

How long is the job schedule?

How do you get to know which job you have to do next?

Are there situations in which the manufacturer is responsible for the defects/issues? Describe, please!

3 Mobile working

General questions

There is a mobile working unit in the workshop. Who is working as mobile worker?

Do you often work as mobile worker?

Characterise please the working procedures as mobile worker!

Is the mobile worker responsible for remote repairs for a day?

Is the mobile worker sent out for just one urgent job?

Do mobile worker use job cards as well?

When are you working as mobile worker? What are the reasons for?

What kinds of jobs are typical for mobile working?

Characterise the jobs/defects that have to be done remotely!

What kind of vehicles do you repair as mobile worker?

Are there any jobs that cannot be done by the mobile workers – just by the manufacturer?

Please describe a concrete scenario when a mobile worker is looking for information. This scenario should occur frequently.

4 Customers

Please list your customers!

Which services do you provide to which customer?

5 Information Sources

Which information sources are available in the workshop?

> When/where are which information sources available?

> E.g. at workshop, in the mobile TEW cars, by telephone (experts) etc…

> What do the information sources contain?

To which services provided by TEW are which information sources available?

Working areas: To which vehicle which information sources are available?

Which communication devices are available during work?

Do you use computer-based systems?

6 Information Support

Please describe situations in which you are looking for information?

Are there any problems when looking for information?

How often are you looking for information during one job?

Are you then looking for work instructions?

> For what are you looking mostly?

Which information is necessary?

Where can you get the information from?

How would you assess the reliability of the information?

> How reliable are the manuals?

> How often are the information sources/manuals updated?

Which information support do you mostly utilise for getting information?

Could you describe the information support that you would like to have!

7 Notes

Do you make any notes of problem solving?

> Are these solutions written in the job card?

> What are you doing with "new" information/knowledge?

Collaboration

> Is there any collaboration among the technicians/mobile workers?

Do you work with lessons learnt?

8 Training Facilities

How often do you participate in trainings?

What training skills have you got in training courses?

Do you pass your training skills on your colleagues?

Do all the mechanics participate in the same training courses?

9 AMIRA Vision

Discussion about the AMIRA vision