

# Towards Context-based Information Delivery to Police Officers: A Questionnaire-based Requirements Elicitation Study

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## ABSTRACT

In the area of information system design, the development of context-aware systems which can provide relevant information in a context-driven fashion to support mobile users in crisis management tasks represents a great challenge. Motivated by the fact that police officers are often overwhelmed by too much information, the goal of the MOSAIC project (a multi-officer system of agents for informed crisis control) is to support mobile police officers by a system which delivers contextualized information that is relevant to the task at hand. In order to elicit the information requirements of police officers who are involved in crisis situations, a questionnaire-based requirements elicitation study has been carried out in the context of the work described here. The results mainly shed light on the situation-specific information requirements of police officers in certain scenarios. The design requirements that follow from our study have clearly the potential to guide the design of context-based information delivery systems for users involved in critical situations such as the police officers we target. Our findings thus offer an important contribution to the field of information system design for crisis management.

## Keywords

Requirements elicitation, context-based information system design, crisis situations.

## INTRODUCTION

Police officers engaged in time-critical tasks in crisis situations require relevant information to facilitate their tasks. Interviews revealed that some failures of policemen's task actions can be traced back to the lack of critical information. For example, a policeman let a car violating a red light leave after merely warning the driver because he was not informed that the car had been stolen two days ago. In another case police officers failed to arrive at a garage that was on fire in time because they did not know a crowd of people had blocked the road to the garage. These examples suggest that the provision of pertinent information is crucial for police officers to perform tasks. However, very few applications provide information which can cater to the special requirements of police officers in the typical situations they are involved in. To tackle the challenge of providing time-critical and task-relevant information to police officers, we have designed a conceptual framework for context-based information delivery which automatically detects context changes and accordingly selects information that is relevant to the tasks of mobile users in crisis situations (Hu, 2009). The term "context" in our study refers to any dimension that contributes to characterizing the situation for the purpose of assessing the relevance of information. In order to evaluate the design of a system which provides relevant information for mobile users in specific situations, the requirements of the end users, in our case police officers, need to be taken into account. Therefore, we carried out a questionnaire for requirements elicitation to discover the information needs of police officers in crisis situations.

This paper mainly reports on a questionnaire-based user study which allows us to define requirements which can contribute to the larger goal of designing systems which can deliver contextualized and highly relevant

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information to police officers. Attributing to this user study, the following research questions are addressed: (1) What are the information requirements of the police officers in those situations they are typically involved in? (2) In how far does the relevance of information items depend on the specific phase of a situation? (3) What are the criteria for assessing whether an information item is relevant or not? By eliciting the user requirements based on a number of constructed scenarios, our results reveal that the information needs of police officers largely depend on the specific task they are engaged in. In particular, as the situation in which police officers handle an incident with task procedures evolves, their information needs also change within these different phases. Furthermore, our results allow us to generalize the findings from the specific scenarios we consider, thus yielding a number of generic observations about the relevance of certain information items in certain phases of those situations that police officers are typically involved in.

## MOTIVATION

Police officers face the challenge of dealing with an enormous amount of information (de Lignie and Hu, 2008), which clearly motivates the need for advanced solutions to the contextualized delivery of task-relevant information to them. Considering the fact that critical situations in which police officers execute tasks are fundamentally different from traditional work environments in which workers are involved in standard office work, special requirements should be taken into account when developing a context-based information delivery system to support them. Firstly, police officers need information provision when they are actually engaged in tasks. Thus, the system should fully exploit the context of the task at hand to meet their information needs. Secondly, the system should be aware of the changes to the information requirements of police officers for different phases of the situation they are involved in. Lastly, the system should show a real-time performance.

The elicitation of requirements is a prerequisite for the design of appropriate context-based information delivery systems targeted at police officers. Although we conducted an indicative user experiment in May 2009 with Dutch police officers, the preliminary experimental results were not strong enough to reveal police officers' concrete information requirements. Therefore, in the context of the work described in this paper, a questionnaire-based survey has been designed and conducted, which mainly aims to elicit what information the policemen require in specific phases of the situation they are involved in. We expect that the requirements and observations we gained from our questionnaire-based user study might help us and others in the task of developing information systems providing information relevant to the situation.

## RELATED WORK

In earlier research in the area of exploiting context to support the activities of mobile users, most applications have been mainly restricted to exploiting location information for guiding the adaptive behavior of information systems as in the Cyberguide system (Long et al., 1996). Going one step further, other approaches go beyond the mere consideration of location to consider any information that can characterize the situation of an entity as context as in the SOCAM architecture (Gu et al., 2004). However, approaches such as the above have not taken into account the fact that information requirements are dynamic and can change depending on specific situations of users, and they do not address the information distribution in crisis situations. Instead, our results show that it is crucial to take the specific phase of a crisis situation in which police officers operate into account to assess whether a piece of information is relevant or not.

Overall, we can distinguish at least two types of context-aware systems which are targeted at supporting users involved in crisis situations. On the one hand we have systems which aim to distribute tasks during mobile surveillance in an optimal way. An example of this is the system designed in the MultimediaN project which is aware of officer availability, task priority and proximity to the incident location (Streefkerk et al., 2009). Such systems however only provide notification messages with task allocation advice based on certain contexts, but do not address the issue of assessing the relevance of information. On the other hand we have systems with the goal of improving the communication between team members, such as the We-Centric service prototype which provides hints and reasons to contact police colleagues (Steen et al., 2007). In contrast, we focus on exploiting the contexts of policemen's tasks at hand, and assessing the relevant information given a phase of the current situation.

Context-aware systems should obviously be developed according to the needs of their end users and also evaluated by feedback from them. Streefkerk et al. (2009), for example, first interviewed police officers to analyze the problems that threaten the efficient task allocation and then implemented a system guided by this analysis. In a similar vein, we also interacted throughout the research with the Dutch Police to find the solutions for avoiding information overload. But the main difference is that we aim to elicit the information requirements of police officers in typical phases of situations they need to handle while the Streefkerk's approach is to select

the most appropriate policemen to handle the current incident. Following the requirements elicited from our user survey, a system can be designed which provides relevant and contextualized information to police officers.

## QUESTIONNAIRE

### Purpose and Research Questions

The questionnaire is conducted to reveal the information requirements of police officers in incident response work, and to receive a firsthand sense of how (and if) their information needs change over time and phases when tackling a certain incident. The following research questions are addressed: (1) Are information needs phase-specific? Our interviews revealed that four phases are relevant: (i) ensuring preparedness; (ii) arriving at the spot; (iii) investigating the incident, and (iv) tracking the incident; (2) Are certain types of information more relevant than others in a specific phase? (3) What specific information do police officers require in each phase? We consulted the end users to ask what types of information they are confronted with in most cases, thus six main categories are derived: (a) navigation information; (b) personal safety; (c) personal information including the (c1) absence of criminal records, (c2) presence of criminal records, and (c3) of relevant social relations; (d) nearby incidents information including (d1) attributes, and (d2) high priority activities; (e) incident evidence; and (f) other detailed facts.

### The Questionnaire Design

In order to capture the information requirements, we consulted the police officers about the typical incidents they have handled and designed a questionnaire using a number of artificially designed incidents inspired in the realistic ones. The task of the participants in the experiment was to fill in the questionnaire by indicating which information item is relevant at which stage of the incident. A description of the incident describes the phases of the situation in which police units are engaged. We involved police officers beforehand to define four relatively realistic scenarios each corresponding to a certain incident taking place nearby the Mekelweg, Delft, Netherlands. The participants filling in the questionnaire were asked to step into the role of police units who were supposed to be dispatched to handle the respective incident. The evolution of each incident was explained in the questionnaire with reference to specific phases and time points. We constructed 50 fictive information items that had to be judged by test persons on their relevance in the specific phase as “highly relevant”, “nice to know” or “not relevant”. The participants were also requested to list other relevant items by way of an open question. While each of our test persons filled out the questionnaire for two different scenarios, this paper only shows results analyzed from the most representative one due to the limited space.

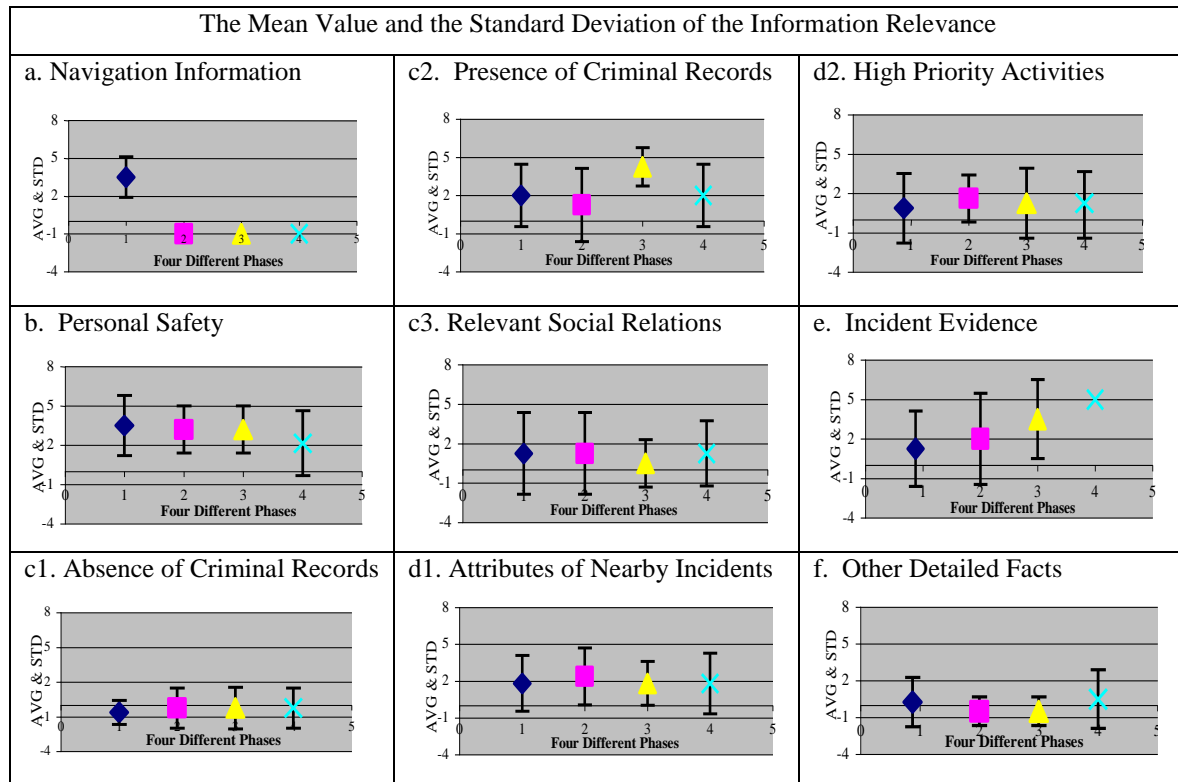
The incident starts when a person –“Joan”- is calling 112 explaining that her car with plate “SZ-VB-69” was hit by another car with plate “01-GBB-1” at the corner of the Mekelweg and the Stieltjesweg around 20:00. Two minutes later, a painter called Tim Drury is calling the 112 reporting that his colleague John Drake has fallen down from the scaffolding at the Mekelweg 136. Two other incidents are reported almost at the same time: a woman’s handbag was robbed by a man riding a black motorbike in the left alley of the Mekelweg, as well as a confused old man having got lost 200 meters down the Mekelweg. The first two incidents, constituting the target incidents, are handled by test persons, and the last two are used to provide additional contexts. As an example, the car collision scenario is presented in the following Table 1:

Time	Phase	Known Context & Information Source	Police Task Procedure
20:00	1.Ensuring Preparedness	Context: involved drivers and cars; location; no victim; aggressive actions. Source: GMS system and RDW database.	Driving to the location of the car collision incident.
20:05	2. Arriving at the Spot	Context: the evidence for the incident description. Source: AVLS system.	Warning about the situation to other drivers; Scanning the RFID chips of driver licenses.
20:10	3. Investigating the Incident	Context: identification of drivers and cars. Source: RFID scanners.	Checking the assurance green cards and the official papers belonging to the cars; doing a routine test on alcohol use.
20:20	4. Tracking the Incident	Context: suspected substances. Source: chemical sensing equipment.	Inspecting one of the cars using a sensor for chemical substances.

**Table 1. The Description of the Car Collision Scenario**

**Data Measurement and Result Discussion**

The relevance ratings of each information item in the specific phase of a situation given by participants are summarized by the arithmetic mean (AM) and the sample standard deviation (STDEV). First, the relevance scale is defined from -1 to 5. Each item is assigned a relevance rating in the specific phase: “highly relevant” is assigned a relevance rating of “5”, “nice to know” is assigned “2”, while “not relevant” column is assigned “-1”. All items are categorized into six predefined categories “a” to “f” (see top of page 3). The results of the relevance ratings for different categories in specific phases can be derived by the comparisons of diagrams in Table 2. Each diagram shows the average estimated relevance of all items in the specific information category for each phase as well as the standard deviation of the relevance by means of an error bar.



**Table 2. Diagram Representation of the Relevance Measurement in the Car Collision Scenario**

The analysis results from the requirement elicitation provide answers to the three research questions we proposed.

*Research question 1:* For items in the same information category the relevance ratings can differ per phase. Diagram “e” for example shows that although incident evidences are irrelevant in phase 1 (ensuring preparedness), they are highly relevant in phase 4 (incident tracking). This finding indicates that the relevance of a given item is clearly phase-dependent.

*Research question 2:* Within a given phase, the mean values of relevance for the different information categories vary. For instance, in phase 1 - represented by the blue diamond - the relevance of navigation information is the highest while the relevance of absence of criminal records is the lowest. This conveys indeed that police officers have different requirements for different types of information in a specific phase.

*Research question 3:* Given that the representativeness of our scenarios has been confirmed by the end users, the information requirements of the police officers in a specific phase of a situation can be derived from Table 2. We only highlight some of the interesting conclusions here: (a) The navigation information to find a route to the incident spot is only relevant when ensuring preparedness. (b) The personal safety information for preventing possible violence is highly relevant in all phases of handling an incident, e.g., personal violence records. (c) The presence of criminal records is important when records may contribute to investigating current illegal actions of involved persons, e.g., drunk driving records; although we assume that social relations are relevant when available evidence can hint at the fact that a closer investigation of the involved person is needed, the relevance rating is not high enough to support this hypothesis. (d) Attributes of the nearby incidents are relevant when the police unit needs to keep an eye open for providing useful information to the nearby colleagues. For example,

the escape direction of the robber is relevant to the police units who are near the robbery spot, although they are not handling this incident; the relevance of nearby activities is higher after arriving at the spot. (e) The evidence which may contribute to the description of an incident is highly relevant in the phase of incident tracking.

## CONCLUSION AND OUTLOOK

In this paper we have reported on our results of a questionnaire-based requirements elicitation method with the goal of revealing the requirements of police officers involved in crisis situations. The analysis results contribute to our understanding of the information needs of police officers and clearly have the potential to guide the design of information systems which can provide relevant information in specific situations.

We have started implementing a system on the basis of the requirements elicited here. All information items are formalized in the RDF (Resource Description Framework) data model. Once the status monitor detects the context model changes, all the rules are triggered to assess the relevant items given a specific phase of the current situation. The rule set we use to assess the relevance of information items has been designed on the basis of the results of our questionnaire analysis described in this paper. One rule is: if a police unit is doing an alcohol test on a driver involved in an incident, then the fact that the driver had a drunk driving record is relevant to the police unit. Another rule is: if a police unit is investigating an incident, then the incident evidence is relevant. These rules have access to contexts captured in the form of a context model.

A context model, which is divided into the general ontology and the specific ontology, is established to represent the phases of certain situations in which the police officers are engaged in tasks. The relations between contextual variables which are essential for the system to assess the relevance of information are semantically described in the model. Parts of the specific ontology in our car collision scenario are illustrated in the Figure 1.

The next step of our work will be to implement the rule sets based on the context model to assess all relevant information in real time as well as to design the strategies to trigger these rules at the right time.

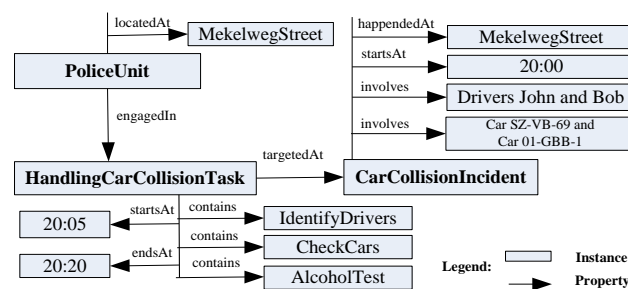


Figure 1. Parts of the Context Model in a Scenario

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