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Abstract

This paper focuses on the design parameters on the part of the stakeholders and users in the design of mobile applications for police officers. Starting from an analysis of the functional requirements of stakeholders and relevant context parameters for police officers, we find design issues that are relevant to the development of context-aware mobile applications for police officers. We collected data from the stakeholders within the police administration as well from the intended users of the service, the police officers, who were asked which specific characteristics and functions mobile applications should be supported in the actual use of mobile applications in specific situations. We found that, whereas most stakeholders are clear and almost unanimous in terms of the functionalities they require, the results for the police officers are more mixed. The use of mobile devices is highly dependent on the context in which police officers have to operate.

Keywords: mobile applications, context-aware, location-based services, we-centric

Introduction

Police organizations are information-intensive and '*intelligence led*' organizations. New advanced mobile services offer the promise that police officers can access the information they need to carry out their tasks more easily, when and where the information is needed. Information is crucial to police officers in carrying out their daily duties. This involves not only obtaining the correct information in a timely and adequate way, but also sharing that information with colleagues and providing information to relevant information systems. Stakeholders within the police organizations consider mobile access to information relevant because it can improve the efficiency, effectiveness and quality of police work. The decision to adopt specific technologies is not made by police officers on the street but, at least in The Netherlands, by managers, politicians and stakeholders in the police organization. Once the decision to adopt a certain technology is made and systems are implemented, it is up to the police officer to decide whether or not he or she will actually use the technology, and whether or not the expected effects can be realized (Bouwman et al., 2005). Before such mobile technology can be used it, has to be designed, which is a process in which stakeholders functional requirements, user needs and task-related requirements have to taken into account. User-centric design (ISO 1998) is essential for the usability of a specific technology. The main questions in this case are how to make information available to police officers or to enable push information, and which device should be used and in which modality, to ensure that the information matches the police officer's specific context, and to increase the performance of the police organization.

Generally speaking, it is hard to assess the potential need for an innovative technology, even for the intended users themselves. A lack of familiarity with a specific technology and its potential use and benefits can act as a barrier to individual adoption and usage. As a result, technologies are not used, initial use by early adopters decreases after some time, or users adapt technologies in ways the designers had not anticipated (Bouwman et al., 2005). It is, therefore, important to gain insight into the design requirements and concepts that explain the (future) use of mobile applications. Consequently, the objective of this paper is to obtain an answer to the following research questions: *What are the relevant context-related, individual and technological characteristics that play a role in the use of mobile technologies by police officers, and where do they conflict with the requirements identified by police stakeholders?* To answer this question we will first review literature with regard to police and mobile applications. Next we will discuss the perspectives of stakeholders and of police officers. Based on the insights derived from the literature and the two discussed perspectives we will present the design of the conjoint analysis, and present the results of the conjoint studies as executed among stakeholders and under police officers. Finally we will discuss the limitations, as well as the conclusions.

Literature Review

The domain under study, i.e. the police organization and the context within which police officers have to carry out their duties, has some very specific characteristics. With regard to context, we not only refer to the organizational setting, culture and structure, and the process in which specific tasks have to be executed, but also to specific requirements that are determined by the public function of police. More specifically, context also refers to the time-space frame, i.e. the direct environment in which police officers have to respond to certain events, the communication partners involved, including colleagues, managers, control room and relevant other parties, and the public at large. In this section, we begin by discussing prior experience with mobile police applications, before moving on to addressing the stakeholders and looking at the police officers' perspective.

Mobile Police Applications

There are several studies that describe the mobile technologies police officers use in their work. Tapia and Sawyer (2005) discuss the implementation and use of PDA and the use of 3G networks in a field trial, while Sørensen and Pica (2005) provide an overview of the Mobile Data Terminals, personal radio and mobile phones used by vehicle response teams. With regard to mobile devices, the authors conclude that voice communication is of central importance. Another important observation is that the use of displays can be highly risky. Looking at a screen instead of observing and communicating with suspects may put police officers in personal danger.

In the Netherlands, mobile technology has been used in some police regions. As in other countries, providing police officers with relevant and reliable information is considered a core aspect of police work. Briefings, information alerts, Intranet and mobile devices such as mobile data terminals, including automatic car location systems, or PDA's, are used frequently, as are PC's, laptops, mobile phones and radio communication devices. Dutch police officers have access to process systems and to a number of databases, at the core of which are the GBA (the common database for registration of all inhabitants in the Netherlands) and RDW (the vehicle database), as well as geographical information systems. As a result of the fact that the various police regions operate independently, two different PDA-based systems have been developed, i.e. Mobiel Blauw and P-INFO. One of these devices is used in some, although not all, of the regions. Although extensive user test and evaluations are being carried out for both systems (Jonge 2003; Kool, Hoogstraten, Den Dunnen and Koning, 2003; Stijnman, Lugard, Slotema and Lith, 2004), they are still only being used to a limited extent. Among the barriers are the elaborate security procedures designed to prevent information from falling into the wrong hands. Limitations with regard to network capacity and coverage are additional barriers. The trade-off between having timely access to accurate information on the one hand, and security limitations on the other, is not always a positive one. Advanced use of mobile devices could reduce the administrative burden for police

officers and improve communications as well as the use of information. In practice, the mobile devices are used more often to retrieve information rather than to upload information to the administrative systems.

Stakeholders Perspective

Our study has focused on the Dutch police organization, which is divided into independent regional offices. The responsibility for a region is divided among the mayor of the region's major city, a regional representative of the justice department and the regional police commissioner. This decision-making body is also known as the triangle. The regional police commissioner is responsible for the regional police force. In the triangle, the expected police performance in a region is laid down in a contract, which defines the core activities and performance indicators of the regional police force. From a decision-making point of view, the most relevant criteria for the use of mobile applications are related to improved performance. Basically, decision-makers expect mobile systems to contribute to a more effective and efficient police organization, but their requirements also are performance-related. Moreover, there is a certain competition between specific regions to be the most innovative police force. In other words, the stakeholders involved the decision-making process regarding the use of mobile applications focus very much on effectiveness, efficiency, improved performance and contribution to the innovative image of the police force as outcome variables.

Earlier research based on in-depth interviews and focus groups in this area provides some important management criteria with regard to mobile systems (De Reuver & Steen, 2008, and Vergouwen, 2006):

- How is the information displayed: text-based only, black and white graphics and pictures, or on color screens.
- Which network is used, in combination with the security level that is enabled by a specific network. The police can use a secured, virtual private network (C2000), with a low data-capacity, advanced secured mobile networks like GPRS/UMTS, or a low security public Mobile Internet network.
- How is authorization organized: task-based, ad hoc or function-based,
- The degree of precision in which the position of police officers can be traced: three meters, as is guaranteed by advanced GPS, or 50 meters, based on the less precise positioning technology offered by network providers.
- The capacity to create temporary groups. Police officers often execute task together with fellow officers and relevant third parties, like other emergency workers, social workers, medical doctors, representatives of the community and municipalities.

Some of the requirements are self-evident. Although, it can be imagined that some security measures might hinder police officers in executing their tasks, i.e. cumbersome secured authorization procedures hinder an effective execution of tasks, and it is not always necessary to make use of highly secured networks. Also some tasks can be executed more effective and efficient by groups that are managed by officers themselves instead of by the control room. However we expect stakeholders not to be very lean and innovative, focused on what is familiar and not was is innovative. Based on the criteria identified above and on the expected outcomes, we hypothesize that according to stakeholders:

H 1 high quality display of information (color), highly secured networks (C2000), function-related authorization, precise location information, and control room-initiated mobile communities will contribute to a more effective, efficient, result-oriented and innovative police force.

It may be clear that stakeholders have a normative and a high level view on functional requirements, whereas the requirements of police officers will be more down to earth, and practical.

A Police Officer's Perspective

In order to understand these more practical requirements, we have to understand the day-to-day contexts in which police officers have to do their work. Literature on police work in relation to the use of mobile information systems is very limited. Sørensen and Pica (2005) provide a detailed ethnographic description of police work in the UK. With regard to the Netherlands, Elias (1997) and Stol et al. (2004), Hoogenboezem and Hoogenboezem (2006) provide insight into the daily practice of policing. The physical context of police work varies all the time: police officers can be on foot, driving a car, working behind a desk, or even ride a horse. They can find themselves in a quiet environment or in a very hectic situation with information coming at them from all directions. The question if and how a police officer uses mobile devices, systems and applications, to a large extent depends on the tasks at hand and on the environment. Using these descriptions of daily police work, Bouwman, Van den Hooff, Van de Wijngaert and Van Dijk (2005) and Pica and Sørensen (2004) draw a distinction between tasks that fit into highly structured and formalized processes, which in general are routine and predictable in nature, and tasks that are part of informal and unstructured processes. Many of the structured processes are supported by workflow or process systems. Although searching for and retrieving information may not be a police officer's core activity, it is a very critical aspect of his or her job (Tapia and Sawyer, 2005). Tasks that are carried out as part of informal processes require a high degree of improvisation and coordination. Whereas structured processes are translated into routines that are prescribed by the information systems being used, ad hoc processes involve the exchange of unstructured information, and the decision whether or not to use any or all of the information that is available in ad hoc situations more often than not has to be made on the fly. We have adapted the task framework suggested by Pica et al. (2004) based on our own observations, focus group discussions and lengthy talks with researchers who work for the police force, to define the context in which specific tasks have to be executed. In our view the context of a task is defined by the police officer's immediate physical environment (at the precinct (office) or on the beat (mobile)) on the one hand, and by the nature of the tasks, i.e. structured (predictable, routine) versus non-structured (unpredictable, ad hoc) (Bouwman et al. 2005, Vergouwen, 2006). The initiation or initiator of a particular task also plays a role, i.e. the police officer responding to incidents in his or her direct environment, the control room, or a briefing at the precinct (task initiation). In addition to the location, nature and initiator of the task, the direction of the information flow is also relevant: actively retrieving information, receiving general alerts, receiving information on request, and storing information in process systems (information flows), have to be considered.

Based on the transcripts of participatory observations (De Reuver & Steen, 2008; Vergouwen, 2006) we have familiarized ourselves with the police domain in different regions, after which we conducted open interviews and focus group discussions at various stages of the research, involving police officers as well as other stakeholders. Based on the discussed literature, information on the police domain and the available technologies, we formulated the following hypotheses, which are all related to the degree of urgency and the degree to which task are structured.

With regard to use, we hypothesize that

H 2 Mobile technologies are more likely to be used in an urgent context in combination with non-structured tasks relative to non-urgent context and structured tasks.

With regard to device preference we hypothesize that

H 3 The device being used will vary significantly depending on the nature (structured vs. unstructured), urgency and location of the task at hand.
- H 3a: PC/laptop will be preferred in the case of non-urgent structured tasks at the precinct
- H 3b: Graphical interface devices will be preferred for non-urgent contexts
- H 3c: Voice communication devices will be preferred for urgent mobile contexts

With regard to task initiation we hypothesize that

H 4 Task initiation will significantly affect device preferences:
- H 4a: PC/laptop will be preferred for tasks initiated by the police officer
- H 4b: Personal radio will be preferred for tasks initiated by the control room
- H 4c: Advanced mobile devices will be preferred for tasks initiated in a briefing

And finally, with regard to direction of information flow, we hypothesize that

H 5 The direction of the information flow will significantly affect device preferences:
H 5a: Graphical interface devices will be preferred for information requests
H 5b: Personal radios will be preferred for receiving information
H 5c: Advanced mobile devices will be preferred for providing provisioning

To test the hypotheses with regard to the police officers and the stakeholders involved, we used conjoint analysis.

Methodology

Conjoint measurement (Vriens, 1995; Molin, 1999) is a common technique used to identify consumer preferences in a multi-attribute decision-making situation. Studies that use conjoint measurement are helpful in providing insight into the relationship between tasks, technologies and context. Conjoint analysis (Gustafsson et al. 2003), also known as factorial survey and vignette studies (Rossi and Anderson, 1982), offers a valuable alternative, because it integrates the strict factorial design and the concept of attribute orthogonality, and because it can be applied in research into the future use of information technology (Van de Wijngaert,1999; Van de Wijngaert, & Bouwman, 2008). In a conjoint analysis, respondents are presented with fictitious cases, also know as conjoints. In consecutive cases, the specific task and context characteristics are changed systematically. Variations with regard to respondent preferences provide insight into the task-related and context-related characteristics influence the use of, for instance, mobile technologies.

Stakeholders Conjoint

As far as the stakeholders are concerned, we used the following list of attributes and levels in the conjoint analysis:

- In addition to ordinary speech connection, information is displayed as text only, black and white graphics/picture, and color graphics/picture;
- Networks and security levels: C2000 high, GPRS/UMTS limited, Mobile Internet low;
- Authorization: task-based, function-based, ad hoc;
- Positioning: three meters, 50 meters;
- Community initiated by: officers, control room , task–based.

Based on an orthogonal design (Louviere, 1988) this resulted in 16 cases. The descriptions of the conjoints were relatively factual, mentioning specific combinations of levels. We asked respondents to rate the degree to which a specific combination of the functionality being offered would lead to a more effective, efficient, result-oriented and innovative police force. The four dimensions were rated separately.

We sent a web-questionnaire to a number of Dutch stakeholders. From the police organization we received a list of 33 stakeholders involved in making decisions with regard to mobile applications, either from a technical or a policy and management perspective. Twenty-three of the stakeholders we invited to take part in our survey responded to our invitation. It is hard to draw conclusions on the representative character of these respondents because there is no central register with the names of the relevant decision makers, and their background.

Police Officers Conjoint

With regard to the police officers, we used the following list of attributes and levels in the conjoint analysis:

- Urgency: non-urgent, urgent;
- Physical context: mobile, fixed, i.e. at the precinct;
- Task initiation: by police officer, by control room, by briefing;

- Information use: retrieving information, receiving general alerts, receiving information, storing information in process systems and other databases.

Based on an orthogonal design (Louviere, 1988) this resulted in 16 cases. We used narratives to present the conjoints. Below, we provide two case examples:

> ***Description 6***: *During your rounds in the neighborhood, the control room informs you of some people who parked their cars in the wrong place near a conference center not far away, and the control room sends you additional information about the situation. There is no rush.*
>
> ***Description 11****: At the precinct, you receive a report about a row between neighbors. In addition, the information system tells you that there have been previous incidents involving the same people, and that some of the people involved may respond aggressively to police presence*.

We asked respondents to rate, on a scale from 1 (totally unsuitable) to 10 (most suitable), how suitable the following seven combinations of mobile technologies and type of displays would be for the specific cases. The following alternatives were offered:

1. Textual information via desktop (PC or laptop, currently used by police);
2. Textual information via Personal Radio (tetra, currently used by police);
3. Spoken information via mobile handset (GSM, currently used by police);
4. A device that facilitates both spoken information and textual and graphical information on screen, for instance an 'i-mode' enabled telephone with graphical interface or a PDA-like existing systems P-Info or 'Mobiel Blauw';
5. A device, for instance a GPRS-phone, that enables both spoken information and textual and graphical information on screen (black and white pictures, low resolution);
6. A device, for instance a high-end UMTS-phone or advanced PDA, that enables both spoken information and textual and graphical information on screen (color screen, pictures, high resolution);
7. A device, for instance a high-end UMTS-phone or advanced handheld computer, that enables spoken information and textual, graphical and video information (color screen, pictures, high resolution)

The web-questionnaire was sent to Dutch police officers involved in operational police tasks on a daily basis. The respondents were approached via the police organization's Intranet and were invited to fill out the questionnaire by clicking on a link. A hundred and six police officers responded to our invitation. About three quarters of the respondents were male (77%), which comes close to the actual percentage of male operational police officers (population is 82%). This means that women are slightly overrepresented, i.e. sample has 23%, population 18%. The average age is 39 years and on average the respondents had 16 years experience as a police officer.

The data for both conjoint analyses were analyzed on the basis of SPSS 14, including the conjoint analysis module.

Results

We begin by discussing the results of the stakeholder questionnaire, before moving on the results of the survey among police officers.

Stakeholders-Study

The effect of the choice in favor of specific technological options on the effectiveness, efficiency, result-orientation and innovativeness of the police forces is assessed by means of the conjoint analysis. Table 1 presents the results of the part worth utilities (effects) of the attributes and levels at an aggregated level, i.e. combining the judgments of the 23 respondents. The model fit proved

to be acceptable for the four models: Pearsons' R between .93 and .96, and Kendall's Tau between .62 and .86. This indicates a good fit between the estimated utilities and the group rating. The explained variance is high (minimal 87%), even for the limited number of respondents. The low standard error is striking, indicating that there is a low variability in perceived utility. It would appear that the stakeholders have a clear shared perception about the performance criteria of a police organization. Based on the utilities, we can conclude that color interfaces (.82, .68, .69 and 1.04), the use of the C2000 network (.16, .22, .17 and .10), authentication based on function profiles (.17, .16, 24, .and ,20), an exact as possible localization (.24, .22, .23, and .22) and community creation by the control room (.16,.16, .15 and .23) are considered constitute the best guarantee for a police force meeting the requirements of effectiveness, efficiency, result-orientation and innovativeness. Basically, this confirms our first hypothesis

Table 1: *Utilities for more effective, efficient, result-oriented and innovative police forces, by stakeholders*

	effective		efficient		result oriented		innovative	
	utility	St error	utility	St error v	utility	St error	utility	St error
CONSTANT	4.765	.092	4.454	.072	4.629	.076	.4708	.128
Type of information								
Text	-.661	.100	-.506	.078	-.484	.083	-.737	.139
Black and white	-.157	.125	-.172	.097	-.208	.103	-.302	.174
Color	.818	.145	.678	.112	.692	.119	1.039	.201
Network								
C 2000	.161	.100	.216	.078	.166	.083	.103	.139
GPRS/UMTS	.079	.115	-.005	.090	-.030	.095	.086	.160
Mobile Internet	-.239	.115	-.211	.090	-.137	.095	-.189	.160
Authorization								
Task	-.070	.100	-.122	.078	-.142	.083	-.087	.139
Function	.174	.122	.156	.095	.237	.101	.198	.170
Ad hoc	-.104	.117	-.035	.091	-.095	.096	-.112	.162
Positioning technology								
3 meter	.240	.075	.216	.058	.232	.062	.221	.105
50 meter	-.240	.07	-.216	.058	-.232	.062	-.221	.105
Community created by								
Officers	-.055	.100	-.085	.078	.040	.083	-.153	.139
Control room	.166	.122	.165	.095	.152	.101	.232	.170.
Task-based	-.112	.117	-.080	.091	-.192	.096	-.078	.162
N	22		23		21		20	
Model fit statistics	Value	Sig.	Value	Sig.	Value	Sig.	Value	Sig.
Pearsons R	.953	.000	.957	.000	.952	.000	.930	.000
Kendalls Tau	.814	.000	.809	.000	.857	.000	.616	.000

In conclusion, the opinions of the stakeholders are relatively straightforward. They prefer the most advanced technologies that support traditional processes. However, based on their preference for the initializing role of the control room, and for authentication based on functional profiles, we can conclude that they want to keep current process unchanged.

Results of the Survey among Police Officers

The effect of the various context parameters on the perceived utility of the specific devices is assessed by means of a conjoint analysis. Table 2 contains the aggregated results of the analysis of the part worth utilities (effects) of the various attributes and levels. The model fit proved to be acceptable for all the nine models: Pearsons' R between .75 and .95, and Kendall's Tau between .55 and .88. This indicates that there is a reasonable fit between the estimated utilities and the subject or group rating. The explained variance is lowest for the most advanced mobile technology and the highest for personal radio, i.e. the mobile technology with which police officers are most familiar. The high standard deviation for the utilities stands out, indicating a high variability between the respondents with regard to perceived utility. However, this is common in conjoint studies (Gustafsson et al, 2003; Molin, 1999). Some of the findings are highly relevant. First of all, the effect of the physical context, either at the precinct or in the field, attracts attention. In an office environment the utilities are highest for PC or laptop (.60), while in urgent situations the personal radio (.19) and traditional mobile phone (.20) have the highest utilities. The more advanced technologies have negative utilities in a non-urgent office environment, and a positive but lower

utility in an emergency situation. In a mobile context, personal radio (.28) and traditional mobile phones (.27) have the highest utilities, while in urgent situations the role of personal radio becomes more explicit (.47), although the utilities for the more advanced (.30 and .31), high tech phones are slightly higher than they are for traditional GSM phones (.29).

If a task is initiated by the control room, there is no clear preference, and all the utilities are low (ranging from -.09 to .11). The utility for briefings is the highest for advanced mobile devices (.39 and .38). If a task is initiated by the police officer, the utility is highest for the traditional PC or laptop (.37), while the advanced technologies score high negative utilities (-.48 and -.49).

Utilities are positive for advanced devices used to retrieve information (.21 and .15). Speech radio and GSM handheld have negative utilities. Information alerts have the highest utilities for the devices that are currently in use: personal radio (.62) and GSM (.48). PC and laptop have negative utilities. The same pattern is found with regard to information provided by the control room: personal radio (.63) and GSM (.43). Advanced technologies have negative utilities (-.22 and -.23). When it comes to administering information, the traditional PC and/or laptop (.87) is preferred. Clearly, the benefits of using advanced devices to administer information are not seen by police officers. This is in sharp contrast to commonly held beliefs that using advanced devices would help officers deal with administrative burdens.

***Table 2**: Utilities with regard to preferred devices by police officers*

	Text with PC or Laptop		Personal radio (porto).		Speech mobile phone		Speech and text		Speech. text and black and white images		Speech. text and color images		Speech. text and video	
	utility	St error	utility	St error	utility	St error	utility	St error	utility	St error	utility	St error	utility	St error
CONSTANT	6.028	1.700	5.382	1.819	5.238	1.739	6.043	1.587	5.806	1.930	7.059	1.744	6.279	2.111
Physical context/ urgency														
Office not-urgent	0.603	0.955	-0.948	0.897	-0.762	0.896	-0.331	0.846	-0.125	0.653	-0.040	0.832	-0.016	0.874
Office urgent	0.004	0.804	0.193	0.814	0.204	0.756	0.179	0.711	0.048	0.542	0.097	0.742	0.053	0.702
Surveillance. not urgent	-0.220	0.882	0.280	0.885	0.268	0.898	-0.025	0.946	-0.168	0.769	-0.361	0.902	-0.350	0.891
Surveillance. urgent	-0.387	0.996	0.475	0.851	0.289	0.879	0.177	0.685	0.245	0.735	0.304	0.861	0.313	0.849
Task initiation														
Control room	-0.095	0.475	-0.010	0.500	0.054	0.475	0.035	0.480	0.085	0.387	0.091	0.505	0.107	0.469
Briefing	-0.273	0.658	0.021	0.601	0.145	0.624	0.068	0.539	0.240	0.528	0.387	0.660	0.382	0.661
Police officer	0.368	0.599	-0.011	0.614	-0.199	0.544	-0.103	0.606	-0.325	0.651	-0.477	0.852	-0.489	0.682
Information use														
Information request police officer	0.028	0.727	-0.149	0.734	-0.026	0.726	0.119	0.649	0.036	0.618	0.210	0.854	0.150	0.746
Attendance information	-0.273	0.689	0.620	0.951	0.476	0.793	0.157	0.738	0.240	0.713	0.250	0.798	0.108	0.777
Information via control room	-0.625	0.957	0.630	0.939	0.433	0.790	0.126	0.673	0.002	0.653	-0.225	0.876	-0.226	0.888
Information administration	0.870	1.201	-1.101	1.274	-0.883	1.161	-0.403	0.934	-0.279	0.803	-0.235	0.933	-0.031	0.961
N	103		103		103		104		104		101		101	
Model fit statistics	Value	Sig.	Value	Sig.	Value	Sig.	Value	Sig.	Value	Sig.	Value	Sig.	Value	Sig.
Pearsons R	0.841	0.000	0.947	0.000	0.924	0.000	0.847	0.000	0.896	0.000	0.795	0.000	0.751	0.000
Kendalls Tau	0.550	0.001	0.879	0.000	0.750	0.000	0.544	0.002	0.706	0.000	0.544	0.002	0.577	0.001

We can conclude that text input using PC or laptop is especially suitable in non-urgent office situations. When an urgent situation arises while police officers are at their precinct, their preferences change toward traditional and familiar technologies. Generally speaking, all technologies are relevant in urgent situations, both in an office environment and on the beat. In the latter case more advanced technologies are expected to be beneficial. There is a clear preference in favor of receiving task-related briefings on highly advanced equipment, rather than on a PC or laptop. On the other hand, police officers prefer using a PC or laptop when they initiate a task themselves. If information, i.e. alerts or messages from the control room, is sent, there is a clear preference in favor of the traditional personal radio and the GSM. As far as retrieving information is concerned, police officers have slight preference in favor of using advanced mobile technologies. Administering information is preferably done via a PC or laptop.

Hypothesis 2 (urgency is positively related to use of mobile technologies) is supported. Hypothesis 3 has to do with preferences regarding devices to carry out urgent tasks whether in the office or in the field, is confirmed. Police officers will use any device that helps them gather as much information as possible. In emergency situations there is a clear preference in favor of mobile phones or PDA's with speech functionality. However, personal radio has the highest utility on the beat. Hypothesis 3a (regarding the relationship between non-urgent situations and traditional technologies), is also supported. PC or laptop are preferred at the precinct, including when it comes to administering information. Hypothesis 3b, which states that, in situations involving non-urgent tasks, mobile technologies with a graphical interface are likely to be preferred, is partly rejected. It holds true with regard to the preference in favor of speech interface (hypothesis 3c) above GUI's, but has to be rejected when it comes to the use of GUI's in non-urgent situation, when the tasks that have to be carried out are part of a structured process. Hypothesis 4, which deals with the different ways of task initiation and device preferences, is partly supported. Police officers stick to their traditional PC or laptop. This is not so much the case for personal radio. Speech radio utility is close to zero. With regard to tasks that are initiated by the control room, we expected personal radio to be the preferred means of communication and information exchange. Although the utilities are not very high, they tend to favor the more advanced technologies. Hypothesis 5 concerns the preferred media for information requests en information provision and is partly supported. Our most important assumption was that police officers would favor advanced mobile handsets for providing information to the process systems and other relevant databases. However, with the exception of PC or laptop, all devices have negative utilities, implying that these media are considered less suitable. Hypothesis 5 is supported with respect to attendance information and information from the control room. All in all, most hypotheses are supported or partly confirmed. Context-related variables play an important role in the preference in favor of specific devices and functionalities. These choices vary from situation to situation, and with subtle differences, implying that careful research into the different conditions governing the use of specific mobile devices is highly relevant.

In the previous section, we presented the results of the survey we conducted among various stakeholders (e.g. managers, decision-makers) with regard to mobile services. In fact, these stakeholders think that more advances mobile devices, with color graphical interface and highly secured networks, offer a serious contribution to the overall efficiency and effectiveness of a police force, which the police offers who are expected to use the various available devices relate the technologies involved to specific contexts and tasks.

Conclusions, Limitations and Discussion

In our study, we interviewed a number of stakeholders regarding the characteristics of devices they feel would benefit police work and should be made available to police officers. At the same time, we asked police officers to indicate their preferences with regard to a variety of devices related to specific contexts. Police work to a large extent depends on information and communication, which means that the exchange of information is crucial. Furthermore, police officers operate in various contexts on a daily basis, and they are used to carrying several communication devices. We performed conjoint analyses to assess the effects of context-related and task-related variables with regard to respondent preferences. Comparing the different preferences of police officers and other

stakeholders provides insight into the opportunities for developing specific mobile applications. The higher-level stakeholders set the boundaries in which police officers have to decide whether or not to use specific applications. Stakeholders take a rather formal and traditional view on advanced mobile applications, being sure that networks are secured, the control room is in control, and avoiding advanced we-centric applications. Insights from the conjoint analysis of the survey among police officers may help stakeholders to readjust the criteria on which they base their decisions.

Conjoint analyzes helps test in a non-obtrusive way which concepts explain future behavior, even when we use a fairly generic definition of context-related concepts. It is clear that more conceptual work on context-related characteristics is needed if we are to grasp the implications of mobility with regard to mobile applications and systems. If we compare general opinions and embed them in user cases, the benefits of conjoint analyses become clear. For instance, when we talked to police officers face to face, they expressed an interest in using advanced PDA's to store information in the process systems. When we systematically vary core concepts in user cases, the opposite is true, i.e. police officers are unlikely to use advanced devices to administer information. This makes it clear that designing and developing technologies that will fit personal and contextual characteristics is an art in itself. As a concluding remark we would like to say that the results of the conjoint analyses were actually translated into more specific user requirements, which again will be tested using conjoint analysis. The same requirements are also used for the development of new mock-ups and prototypes. Our approach based on conjoint analysis with regard to the development of new services helps to prevent investments being made in new services that will not be used in practice, making it possible to build a more effective police organization, which will eventually result in a safer society.

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