DESIGN OF A MOBILE SERVICE PLATFORM FOR PUBLIC EVENTS – IMPROVING VISITOR SATISFACTION AND EMERGENCY MANAGEMENT

Heiko Roßnagel, Jan Zibuschka[1], Jan Muntermann, Tobias Scherner[2]

Large public events are quite common in metropolitan areas and those being responsible for the organization have to cope with high complexities. Due to high concentration of individuals, incidents can have devastating effects. Here, emergency management systems utilizing mobile communication infrastructures can provide support. In this contribution, we present the design process of an emergency management system based on mobile communication infrastructure, which allows the integration of mobile value-adding services. We demonstrate that it meets requirements derived from literature better than existing systems. We also present in detail the design process of the system, which was developed using a scenario-based design approach, based on results of interviews with various stakeholders. In addition, we present exemplary mobile commercial services that can be integrated into the EMS and discuss the benefits to the users of such a system.

1. Introduction

The crucial role of efficient information provisioning in the management of unforeseen critical events such as crises and emergencies is well recognized today. As shown in recent studies (e.g. [10]), information technology can provide means to efficiently respond to such critical events by providing a coordination mechanism to collect, process and distribute relevant information across relevant organizations and individuals. In contrast, inefficient information management such as delayed or inadequate warning or a lack of organizational coordination may even worse the consequences of such incidents and fail to limit social and economic impacts [3]. In this paper, we highlight the importance of efficient information management to mitigate the impact of emergencies that can occur during large public events. However, we will focus on an issue that hasn't been paid to that much attention in the existing literature in the past and explore commercial opportunities that could come along with emergency management infrastructures installed. On the basis of an emergency management system (EMS) that has been proposed by [20] we present different scenarios of public events and explore how commercial services that utilize the same infrastructures as the EMS can provide benefits to both the individuals that visit a public event and the event management industry that can realize new business opportunities. We therefore propose a multi-layered platform architecture that provides a conceptual for an integration of commercial services and emergency management services. From an emergency management perspective, this architecture design gives a competitive edge for two reasons: First, the costs of operating the EMS infrastructure can be reduced by providing and selling services that are interesting for

[1] Fraunhofer IAO, Nobelstr. 12, 70569 Stuttgart, Germany, [firstname.lastname]@iao.fraunhofer.de

[2] Goethe University, Grüneburgplatz 1, 60323, Frankfurt, Germany, [muntermann; scherner]@wiwi.uni-frankfurt.de

the event management industry. Second, from a perspective of the users of such a system, it is beneficial that the users are familiar with (quite similar) commercial services and then have the experience when emergency management services are provided. Our paper is structured as follows. In the next section, we present a foundation of our research that is based on the Design Science research paradigm. Then, section 3 provides an overview of existing EMS, their shortcoming, and an alternative approach that provides a basis for our research. Section 4 presents and explores three promising examples of large public events, for which the benefits of exemplary integrated commercial services are presented. Our paper concludes with limitations of our research and the conclusions.

2. Design Science Research Approach

The problem of minimizing the impact of crises or disasters and at offering novel services to customers is addressed by a conceptual system design in the following that aims at providing a basis for offering both commercial service and emergency management functionalities. This system design represents an IT prototype, i.e. an artifact instantiation that aims at the two functionality requirements. As system architectures, system designs or prototypical software applications, IT artifact instantiations demonstrate the feasibility of an approach developed. Design science research contributions present novel IT artifacts and suitable evaluation approaches that address the artifact's appropriateness to contribute to the problems' solution [13], which we have illustrated before. These two facets of design science-oriented research contribute to the foundations and the methodologies pool of Information Systems research, i.e. they contribute to its knowledge base [8]. An EMS system design concept is presented in the following, which utilizes communication facilities of mobile communication networks such as GSM. In contrast to existing approaches such as the Global Disaster Alert and Coordination System (GDACS) [4], our system architecture design provides facilities for integrating EMS functionalities and commercial services on the basis of a common platform. We present in detail the design process of the system, which was developed using a scenario-based design approach, based on results of interviews with various stakeholders. In order to evaluate our proposed system design, we then present exemplary commercial services that demonstrate its feasibility. Further evaluation is provided by a qualitative analysis of potential benefits being provided to the different parties including the public sector, commercial service providers and customers. Consequently, we aim at following a design science-oriented research approach [11] and present a conceptually developed and prototypical implemented IT artifact.

3. Emergency Management Systems

The design of the proposed EMS infrastructure is based on an analysis of system requirements provided by [20]. Based on a literature review, seven relevant requirements were identified, which comprise (1) system effectiveness [9], (2) reliability [24], (3) cost efficiency [24], (4) smooth service integration [17], (5) multilateral user interaction [22], (6) availability [5], and (7) security [23]. Before presenting a conceptual system design addressing these requirements in section 3.2, the following section provides an overview of existing approaches and an assessment on how those systems address the requirement elements.

3.1 Existing Emergency Management System approaches

Several initiatives and research projects are working on possibilities to facilitate mobile communication networks for EMSs. Most initiatives, as those described below, are concentrating on certain phases of disasters [12]. The GDACS [4], an initiative initially launched by the European Commission, focuses on gathering information about earthquakes and tsunamis. The system automatically evaluates their impact and disseminates the information to prior registered persons around the world. Messages are delivered by SMS or E-mail, depending on the customers preferences. We conclude that the approach addresses the requirements of cost efficiency by using commonly available communication channels. However, effectiveness is only partially addressed because warnings will only be send to persons who have registered for the service.

The Commercial Mobile Alert System (CMAS) [6], an initiative of the United States Federal Communications Commission, will allow the Federal Emergency Management Agency (FEMA), to accept and aggregate alerts from the President of the United States, the National Weather Service (NWS), and state and local emergency operations centres, and then send the alerts over a secure interface to participating wireless providers, who will distribute the alerts to their customers. CMAS differentiates between three different categories of alerts. The first category (presidential alerts) includes terrorist attacks and will be transmitted to all activated cell phones in a defined geographical area. The other two categories, Imminent Threat Alerts (including hurricane and tornado warnings) and Child Abduction Alerts, can be deactivated by an “opt out–option”. So far, no definite plans how to implement the Commercial Mobile Alert System are available and thus conclusions on the effectiveness of the system are not possible. Ensuring availability during emergency cases is always extremely difficult. However, being able to generate additional revenues by integration of commercial services may lower the reluctance to invest into the reliability of networks. Both presented initiatives are currently lacking of this option.

3.2 Conceptual System Design

The proposed system design is based on [20]. To open up the system design to commercial service providers, we have defined roles of the public sector and the event management industry. Both entities are operating on a subset of responsibilities and features that the whole system provides. Therefore, their roles are introduced as sub-roles. They have access to the underlying communication infrastructures and thereby, each provides specific services the stakeholder is specialized in. The central component in our design is the service platform, which is maintained by the platform operator. The platform communicates with mobile network operators and provides basic services for service providers from the event management industry and the emergency manager via standardized service interfaces. The basic services include localization of mobile subscribers, message delivery via SMS and CBS, multilateral data transfer, access to information databases, support for mobile communities and billing services for mobile payment and mobile ticketing [20].

4. Commercial Service Integration

We will now focus on exemplary commercial services and their integration with the EMS. After a description of potential exemplary services we will discuss service integration and economic feasibility. A broader discussion of services for major events that are suitable for integration into an EMS can be found in [19].

4.1 Design Approach

Initially, we intended to follow a user-centric design approach, as needs of stakeholders in the event management and disaster response scenarios are likely fragmented, motivating use of an approach for collecting those requirements [21]. However, results of initial interviews proved contradictory and inconclusive, with many stakeholders having strong objections to any change of processes whatsoever. This is also in line with the findings from [21] that user-centric design tends to undermine design and development of innovative solutions. For this reason, we employed a scenario-based approach, as mandated by Carroll [2] and others. This approach also shares the advantage of aiding in analyzing benefits and challenges of emerging information systems architectures [2]. In addition, an agreement on relevant scenarios was one of the coherent results of the initial stakeholder interviews, offering a solid empirical basis for this approach. The scenario-based approach also is very appropriate for complex multi-stakeholder requirements, as it is useful when design moves have multiple effects, and external factors constrain design [2]. The identified scenarios are given in the next section, and valuable capabilities our system can offer to stakeholders are identified. Only one scenario will be given in full detail to keep this contribution readable.

4.2 Scenarios for Identification of Commercial Services

Large public events can differ quite substantially and often have very different requirements. Therefore, organizers and authorities have to address very different issues according to the nature of the particular event. For example a football match takes place in a closed environment (stadium) and some of the attendees might be hooligans willing to commit violent acts [15] while a church day takes place in an open environment and attendees are usually not violent. In order to be able to support several types of public events, we have developed a typology with 16 different dimensions and classified public events according to their particular dimension attributes in [18]. We have picked and will explore three exemplary events in the following that cover a very broad spectrum of those dimensions. Those events are a football match, the “Kölner Lichter” and a church day. We will only describe the Kölner Lichter scenario in full detail, giving an overview of the other scenarios

Football match scenario: Football matches are events that occur on a weekly basis. They are sporting events that take place in a stadium. They have a rather mild effect on the public and individual traffic system, because they occur very often and authorities and public transport providers have a lot of experience handling the traffic consequences. The event lasts for a couple of hours and attracts less than 100,000 visitors. Most of these visitors are from the local area and some of them might be hooligans.

Several mobile services could provide value to the visitors of football matches. One obvious example are push services that provide the fans with live scores on the other matches that take place at the same time around the league. Another example is the ability to communicate with other fans. Using their mobile device visitors could twitter about the game, chat with other fans or make photos and upload them to a server. Other mobile services that could provide additional value are mobile payment and mobile ticketing.

“Kölner Lichter” Scenario: “Kölner Lichter” is an annual event that takes place at the Rhein River in Cologne. Several music bands perform on stage and the music is being broadcasted all along the riverside. There is no fee for attending the event and it takes place in an open environment. The event ends at midnight with spectacular fireworks that last about half an hour. Usually this event attracts between 500,000 and 1,000,000 visitors every year. Due to

fixed ending point and the high number of visitors, this event has a huge effect on the public and individual traffic system. However, since this is an annual event authorities and transport providers can prepare themselves based on prior experiences.

Figure 1: Sabine and friends at Kölner Lichter (photograph illustrating scenario)

- The main actor of our scenario for this event is Sabine. Sabine has an appointment with some of her friends to meet and enjoy the fireworks at Kölner Lichter together. However, when she arrives, no one is at the meeting point. She uses a Friend Finder service on her mobile which performs a positioning of her and her friends and helps her find them. Later, Sabine receives a call from her friend Rolf, who arrives late, and is still looking for a parking space where he can leave his car. She has the current capacity utilisation of the surrounding car parks listed on her mobile, and tells Rolf where to go. As they are wating for the fireworks, Sabine takes a photo of the group using her mobile phone. It is automatically geotagged. She uploads it and shares it with her friends who are not there (using a microblogging service). A suspicious carrying case is found close to the group. Police want to evacuate the surrounding area to protect against a potential bombing. Cell Based Broadcast is used to send a warning message, along with routing information, to surrounding mobile phone users registered at the local cells. Sabine receives this warning and leaves the area together with her friends. Later on, she records a video of the fireworks, geotags it, and uploads it. After Kölner Lichter she uses a routing service on her mobile phone to find after event parties. We also generated media to help us envision the event (see Figure 1 for an example).

As we can see from this scenario, mobile friend finder service could provide some value to visitors of such an event, because it can be very difficult to find other people in the mass of visitors. Also the ability to document the event by taking pictures or videos and to publish them immediately on the internet using twitter or similar services can be an attractive service. In addition, location based services as for example routing to points of interests, such as bars with after event specials could provide some value to the visitors.

Church Day Scenario: The protestant church day is an event that takes place annually but changes from city to city. So from the perspective of the city that hosts the church day, it is a one-time event. It attracts over a million of visitors, including a lot of foreigners. The organizers have a lot of experiences from previous church days but local authorities and transport providers are usually confronted with this event for the first time. The church day

itself takes place in an open environment and comprises several sub events that take stage at different locations all over the city.

Similar to the football and "Kölner Lichter" scenarios the ability to communicate with others using chat or twitter services could be an attractive mobile value adding service. Also the ability to document the event using pictures and videos and to publish them on the internet should be interesting. Since a lot of the visitors are not from the local area, location based services, such as routing or points of interest, could be particularly useful in this scenario. Another promising service category are mobile services that support group management, because a lot of the visitors travel to this event in groups and group members might be spread out over the event area and might lose sight of each other.

4.3 Derived Layered Platform Architecture

Layered architectures for the implementation of mobile services have been proposed by several authors [1] [7] [25], as they improve interoperability with various mobile phone and network platforms and protocols, and enable the provision of services based on reusable infrastructure components. Our layered architecture is a result of underlying capabilities derived from the scenarios (as described in section 4.2), and its main benefit lies in reuse and composability of services, in the spirit of service-oriented computing [14]. Based on the underlying infrastructure, we implemented several basic services reflecting essential capabilities. Those are integrated into more complex services with direct application character, which may be both commercial and disaster management services, in the next layer. In the final layer, the services are integrated into scenario-specific application packages (see Figure 2).

The service platform provides basic services on which event management and emergency service can be built. Since the same underlying technology is used for both types of services, economies of scale have a significant impact on costs of these services. Furthermore, the central platform offers service providers from the event management industry, which is largely driven by small and medium enterprises, a possibility to offer mobile services without the necessity to maintain the underlying infrastructure. Integrating these services into an EMS improves users' familiarity with the system while at the same time offering a perceived value to the customers. Signalling preparedness to prospective visitors has a positive impact on the event's reputation which may increase its popularity [20].

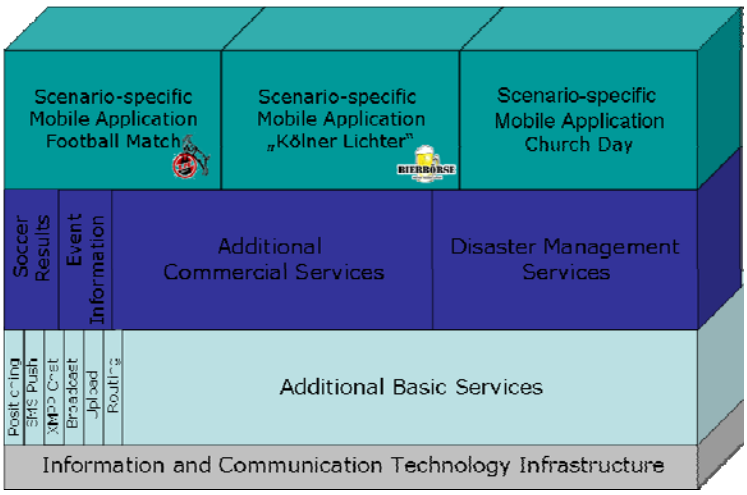

Figure 2: Overview of platform layers

5. Limitations

First steps on how to combine emergency and commercial services via the same infrastructure have been sketched out. However, a detailed analysis and estimation of the impacts and interdependencies of a jointly used infrastructure on the development and the acceptance of mobile emergency services is still missing. The discussed advantages of this approach are limited by the degree of cooperation which decision makers of emergency services might be willing to allow. Also, usability aspects of such systems, like possible steps to ensure that the users pay attention to incoming messages, need to be further researched. A first step in that direction is to use different acoustic and visual signals for emergency and commercial services to raise the awareness of the users. Furthermore, the availability of different infrastructural components is a major issue and precautions against breakdowns have to be incorporated into networks. Evaluating the readiness of infrastructures for mobile emergency services remains a challenging subject for further studies.

6. Conclusion

In this contribution, we presented the design process of an emergency management system based on mobile communication infrastructure, which allows the integration of mobile value-adding services, and demonstrated how it meets requirements we derived from a literature survey. In addition, we presented exemplary mobile value-adding services that could be integrated into the EMS and discussed the benefits to the users of such a system. From the perspective of competitive strategy [16], the open platform could provide a competitive advantage compared to other economies that do not offer similar infrastructures. Future analyses could therefore address the question how the proposed system design can positively contribute to the profitability of different involved industrial sectors like mobile operators and the tourism industry. Our developed prototype will furthermore provide the technical basis for future empirical evaluations.

Literatur / References

[1] Cannataro, M., Pascuzzi, D., A Component-Based Architecture for the Development and Deployment of WAP-Compliant Transactional Services, Proceedings of the 34th Hawaii International Conference on System Sciences, 2001.

[2] Carroll, J., Five reasons for scenario-based design, in: Interacting with Computers, 13/2000, S. 43-60.

[3] Dantas, A., Seville, E., Organisational Issues in Implementing an Information Sharing Framework: Lessons from the Matata Flooding Events in New Zealand, in: Journal of Contingencies and Crisis Management, 14/1/2006, S. 38-52.

[4] European Communities: Global Disaster Alert and Coordination System (GDACS) Homepage, *http://www.gdacs.org/*, 2008-11-21 (2008).

[5] Faulkner, B., Towards a Framework for Tourism Disaster Management, in: Tourism Management, 22/2001, S. 135-147.

[6] Federal Communications Commission, New Commercial Mobile Alert System, http://www.fcc.gov/cgb/consumerfacts/cmas.html, accessed 2010-03-03.

[7] Fouial, O., Quesnel, S., Royard, P., Demeure, I., Advanced Service Provision Architecture for Mobile Computing Environments, IST Mobile Summit 2002, 2002.

[8] Hevner, A.R., March, S.T., Park, J., Ram, S., Design Science in Information Systems Research, in: MIS Quaterly, 28/1/2004, S. 75-105.

[9] Johnston, D., Becker, J., Gregg, C., Houghton, B., Paton, D., Leonard, G., Garside, R., Developing warning and disaster response capacity in the tourism sector in coastal Washington, USA, in: Disaster Prevention and Management, 16/2/2007, S. 210-216.

[10] Leidner, D., Pan, G., Pan, S., The role of IT in crisis response: Lessons from the SARS and Asian Tsunami disasters, in: The Journal of Strategic Information Systems, 18/2/2009, S. 80-99.

[11] March, S.T., Smith, G.F., Design and natural science research on information technology, in: Decision Support Systems, 15/4/1995, S. 251-266.

[12] McEntire, D.A., Fuller, C., Johnston, C.W., Weber, R., A Comparison of Disaster Paradigms: The Search for a Holistic Policy Guide, in: Public Administration Review, 62/3/2002, S. 267-281.

[13] Nunamaker, F.J., Chen, M., Purdin, T.D.M., Systems development in information systems research, in: Journal of Management Information Systems, 7/3/1991, S. 89-106.

[14] Papazoglou, M.P., Service -Oriented Computing: Concepts, Characteristics and Directions, Proceedings of the Fourth International Conference on Web Information Systems Engineering, 2003.

[15] Phillips, R., Football fans stabbed in West Ham versus Millwall clash, *The Sun News*, 2009-08-26, http://www.thesun.co.uk/sol/homepage/news/2606682/Football-fans-stabbed-in-West-Ham-versus-Millwall-clash.html, 2009.

[16] Porter, M.E., How competitive forces shape strategy, in: Harvard Business Review, 52/2/1979, S. 137-145.

[17] Ritchie, B.W., Chaos, Crises and Disasters: A Strategic Approach to Crisis Management in the Tourism Industry, in: Tourism Management, 25/2004, S. 669-683.

[18] Roßnagel, H., Engelbach, W., Frings, S., Ortsbezogene mobile Dienste zur Verbesserung der Sicherheit bei Großveranstaltungen, in: Roth, J. (eds.), Tagungsband 5. Fachgespräch Ortsbezogene Anwendungen und Dienste, pp. 35-40, Nürnberg, 2008.

[19] Roßnagel, H., Engelbach, W., Frings, S., Weisbecker, A., Mobile Dienste zur Erhöhung der Sicherheit bei Großveranstaltungen, in: Spath, D., Höß, O., Weisbecker, A. (Hrsg.), Stuttgarter Softwaretechnik Forum 2008: Science meets Business, S. 91-102, Fraunhofer IRB Verlag, Stuttgart, 2008.

[20] Scherner, T., Muntermann, J., Roßnagel, H., Integrating Value Added Services into an Emergency Management System for Tourist Destinations, Proceedings of the European Conference on Information Systems (ECIS 09), Verona, 2009.

[21] Tetard, F., Patokorpi, E., Kadyte, V., User-Centred Design of Mobile Services for Tourists: A Case Study on Student Work on Mobile Design, Mobile Information Systems: IFIP TC8 Working Conference on Mobilie Information Systems (Mobis), pp. 155-168, Springer, Oslo, 2004.

[22] Turoff, M., Chumer, M., Van de Walle, B., Yao, X., The Design of a Dynamic Emergency Response Management Information Systems (DERMIS), in: Journal of Information Technology Theory and Application (JITTA), 5/4/2004, S. 1-36.

[23] Valtonen, E., Addams-Moring, R., Virtanen, T., Jrvinen, A., Moring, M., Emergency Announcements to Mobile User Devices in Geographically Defined Areas, Proceedings of Information Systems for Crisis Response and Management (ISCRAM), pp. 151-156, Brussels, Belgium, 2004.

[24] Zeckhauser, R., The Economics of Catastrophes, in: Journal of Risk and Uncertainty, 12/1996, S. 113-140.

[25] Zibuschka, J., Fritsch, L., Radmacher, M., Scherner, T., Rannenberg, K., Privacy-Friendly LBS: A Prototype-supported Case Study, Proceedings of the 13th Americas Conference on Information Systems, 2007.