

Are we prepared? Experiences from developing dashboards for disaster preparation

Nitesh Bharosa

Delft University of Technology
n.bharosa@tudelft.nl

Sebastiaan Meijer

Delft University of Technology
Sebastiaan.meijer@tudelft.nl

Marijn Janssen

Delft University of Technology
m.f.w.h.a.janssen@tudelft.nl

Fritjof Brave

Berenschot
f.brave@berenschot.nl

ABSTRACT

Relief agency managers show growing interest in dashboards for assessing multi-agency disaster preparedness. Yet, there is a dearth of research on the development and use of dashboards for disaster preparation. Consequently, information system architects in the disaster management domain have little guidance in developing dashboards. Here, dashboards refer to digitalized visualizations of performance indicators. In this paper, we discuss the experiences gained from an action research project on the development of dashboards for assessing disaster preparedness. The objective of this paper is to discuss experiences and tradeoffs extracted from the development of dashboards in practice. We organized a two-day gaming-simulation with relief agency managers for the evaluation of the dashboards. While the relief agency managers acknowledged the usefulness of dashboards in the disaster preparation process and expressed their intention to use these in practice, they suggested that the formulation and clustering of performance indicators requires further research.

Keywords

Disaster preparation, performance indicators, dashboards, gaming-simulation, action research

INTRODUCTION

The level of disaster preparedness of relief agencies (i.e., police, fire department & ambulance services) is becoming a higher priority on the agenda of relief agency managers and policy makers. The increasing interest can be partly attributed to the number of major disasters in the past decade (e.g., 9/11, Katrina, London, Madrid). These disasters have exhibited poor levels of disaster preparedness, particularly when it comes to multi-agency coordination and information sharing. As such failures have been exploited by the media, policy makers cannot afford to say, “we were unprepared” anymore to victims and their families in case of a disaster (Boin, 't Hart, Stern, & Sundelius, 2005). Consequently, disaster preparation has regained the attention of governments and relief agencies all over the world.

In the preparation phase, relief agency managers should prepare for the eventuality of an disaster by understanding the vulnerabilities of an organization, analyzing its organizational capability to deal with a range of disaster scenario's, and by taking precautionary measures to mitigate the possible risks of being unable to cope with disaster events. Here, preparation includes analysis, planning, and evaluation. In each of these phases, performance indicators (PIs) are of major importance (Carter, Klein, & Day, 1995). Historically relief agencies such as fire departments and ambulance services define and use their own set of PIs. Each agency does this individually and tailors PIs to their environment. They usually focus their PIs on internal processes, clustered in themes such as financial status, human resources, and support tools. As there is no uniform set of PIs across relief agencies, it is difficult for policy makers to benchmark and allocate (financial) resources based the PIs of other types of relief agencies or relief agencies in other regions. Since policy makers often have a fixed budget available for relief agencies, they need to know how to balance financial resources between agencies in order to maintain an overall level of disaster preparedness in a certain region.

Scholars in the domains of strategic management (e.g., Adam & Pomerol, 2008; Clarke, 2005) have proposed

Reviewing Statement: This paper represents work in progress, an issue for discussion, a case study, best practice or other matters of interest and has been reviewed for clarity, relevance and significance.

the use of dashboards as instruments for both the clustering and visualization of PIs. Here, dashboards refer to digitalized representations of PIs over a certain time interval. Despite the advantages predicted for organizations when using dashboards (e.g., Dover, 2004; Gitlow, 2005; Resnick, 2003), literature on the development of dashboards that indicate the level of disaster preparedness on a multi-agency scale is scarce. While many studies are concerned with the appropriateness or success of response activities, the level of preparedness for disaster management is under-studied. Moreover, literature provides a limited number of experiences on developing dashboards for multi-agency disaster preparation. The objective of this paper is to present experiences and tradeoffs extracted from the development of dashboards in practice. We extract these experiences and tradeoffs from an action research project in which we participated. The PIs formulated in this project were evaluated using a two-day gaming-simulation with relief agency managers. This paper contributes to existing literature on disaster preparation by providing experiences extracted from dashboard development and evaluation in practice. In addition, this paper diagnoses the problems of inconsistent data and PIs for dashboard design and shows how the PIs are translated to dashboards for three different levels of disaster preparation.

This paper proceeds with an overview of an action research project on dashboard development in the Netherlands, followed by a brief description of the resulting dashboard prototypes. Here, we explicitly focus on the design choices and tradeoffs made in this project. Then we discuss the setup and results of the dashboard evaluation process, followed by the design experiences gained from developing dashboards for the purpose of multi-agency disaster preparation. The paper concludes with discussions on the findings and opportunities for further research.

AN ACTION RESEARCH APPROACH TO DASHBOARD DEVELOPMENT

At the start of 2008, the Dutch parliament finally passed a long debated law mandating the formation of twenty-five multi-agency safety organizations. According to this law, the multi-agency safety organizations that were to be formed would act as the main responsible government body when it comes to disaster preparation and response in the geographic region they covered. This meant that previously autonomous relief agencies, including the fire and ambulance services, were now required to collaborate in terms of disaster preparation and response. More specifically, the previously autonomous relief agencies were now dependent of one another in terms of budget allocations for disaster preparation. The law also mandated that the multi-agency safety organizations, of which only a few had already been formed, needed to conduct disaster preparation activities based on standardized and comparable PIs. In order to comply with the law, five out of the twenty-five multi-agency safety organizations went on and agreed to collaborate in the development and use of PIs. The collaboration project was titled 'Aristoteles' (after the Greek Philosopher) and started in August 2008. The main goal of this project was to develop and evaluate PIs and dashboards visualizing the state of disaster preparedness for the operational, tactical and strategic level of the multi-agency safety organization. A coalition of fire departments and ambulatory services had initiated the project and had gathered funding from the Dutch Department of Internal affairs. Since the Aristoteles project was the first of its kind, a large part of this project required the collaboration of both academia and practitioners.

Through an action research type of collaboration, we were able to collect data on the development and evaluation of PIs and dashboards. The motivation for following the action research approach is twofold. First, we wanted to capitalize on the synergy between the university team members' knowledge of dashboard design and evaluation theory and practitioners' practical requirements and constraints. Second, since there were no comparable research initiatives on dashboards for multi-agency disaster preparation, we had no prior understanding we could build upon. Since action brings understanding, the action research approach was the most suitable methodology for our purposes. Action Research in the IS field consists of a repetitive five-phase process: diagnosing, action planning, action taking, evaluating, and specifying learning (Baskerville, 1999). The remainder of this paper is structured according to these five phases of action research.

PHASE 1: DIAGNOSING THE DESIRE FOR CHANGE

The main driver for initiating the Aristoteles project was the lack of standardized PIs for disaster preparation. More specifically, each relief agency in each municipality in the Netherlands (approximately 450) was free in defining and specifying their PIs for disaster preparation. Three factors complicated the development of standardized and comparable PIs on disaster preparedness. Firstly, the high level of autonomy has stimulated the establishment of several sets of PIs in a single municipality or province. This means that on a regional level, each municipality will have different sets of PIs for relief agencies, often related to the type of hazards that a municipality faces. For instance, relief agencies in border municipalities are often interested in PIs regarding the handling of international traffic. Relief agencies operating in a municipality with a high level of chemical production usually focus on PIs regarding the handling of hazardous incidents. Hence, the set of PIs not only

differ per agency, but also per municipality in a region. This heterogeneity complicates a comparison or benchmark of relief agencies and safety regions. Secondly, there is a lack of standards regarding the type of PIs needed, which complicates the measurement of whether or not relief agencies are sufficiently prepared (i.e., trained, capacitated, educated and on stand-by) for a disaster. A third reason lies in the difficulty to formulate PIs that are appropriate of different levels of decision-making (i.e., operational, tactical and strategic). This is related to the necessary level of granularity of PIs. For instance, the commander of the police department will probably be more interested in the number of police officers (i.e., 200, 250) that are directly deployable in case of a disaster, whereas the Mayor is more concerned about the degree of deployability (i.e., high, medium, low).

PHASE 2: ACTION PLANNING

The Aristoteles project was planned to be executed in four sequential phases. Table 1 outlines the main phases.

Table 1: Overview of project phases, activities and deliverables

Project phase	Activities	Deliverables
1. Exploration & PI generation (August 2008- February 2009)	Document analysis and interviews with participating relief agencies	Initial set of performance indicators (long-list)
2. Prioritization of the long-list of PIs (March 2009-May 2009)	Group Decision Support sessions	Prioritized set of performance indicators (shortlist)
3. Dashboard development & evaluation (June-July 2009)	Prototyping & dashboard evaluation using gaming-simulation	Dashboard prototypes and evaluated performance indicators
4. Piloting (October 2009 – May 2010)	Implementation of dashboards in 5 safety regions	Fully operational dashboards and standardized performance indicators

The authors participated in the second and third phase. In practice, the activities in the first and second phase took place in parallel. We discuss these activities during the third phase in the next section.

PHASE 3: ACTION TAKING

In accordance with Morrissey (2007), our dashboard development process consisted of three phases: (1) identifying the main stakeholders; (2) identifying goals and establishing baseline capability for each stakeholder; and (3) selecting strategic, tactical, or operational dashboard content aligned with these goals. The next screenshot illustrates one of the dashboards we developed specifically for the tactical level.

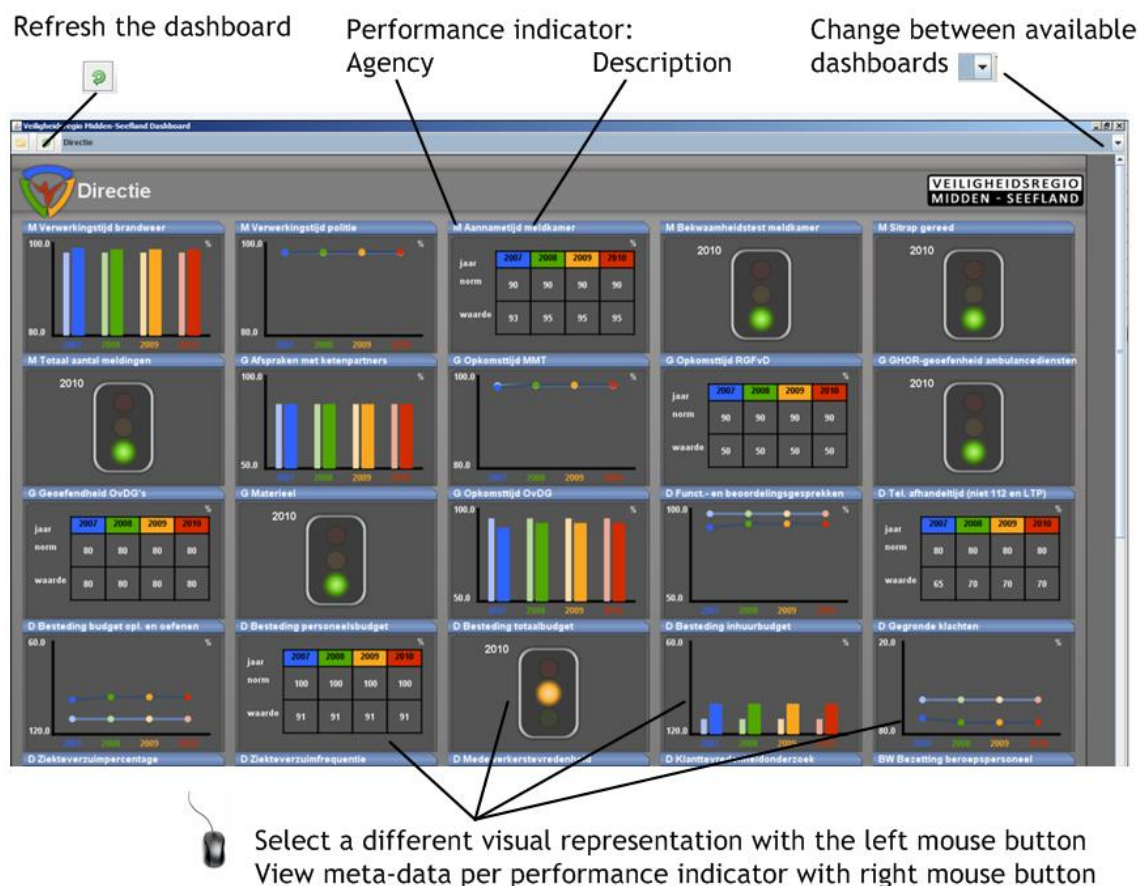


Figure 1: Screenshot of dashboard (tactical level)

Based on the number of relief agencies and three levels that needed to be supported (strategic, tactical and operational) seven different dashboards were developed: one for the strategic level, one for the tactical level and five for the operational level. We discuss the evaluation of these dashboards next.

PHASE 4: DASHBOARD EVALUATION

We evaluated the dashboards described in the previous section using a two-day gaming-simulation with 36 professional relief agency managers. Gaming-simulation is an approach often applied for awareness creation and learning in strategic management and policy formulation (Duke & Geurts, 2004). Meijer et al. (2008) demonstrated that gaming-simulation is also useful for data-collection on supply chains and networks. The objective of the gaming-simulation in this study was to evaluate the dashboards in their ability to support the process of multi-agency disaster preparation. In order to generate a realistic dashboard usage environment, we simulated a fictitious safety region requiring multi-agency disaster preparation. We divided the participants in seven teams each using a different dashboard. Based on the individual role descriptions, messages and context information, the invited relief agency managers employed the dashboards for multi-agency disaster preparation. The scenarios entailed threats of a disaster in an imaginary, yet realistic, safety region in the Netherlands. Acting as facilitators, we simulated several potential disasters (i.e., risks of flooding, passenger train collision etc) that required multi-agency preparation. Accordingly, the relief agency managers were required to engage in several disaster preparation processes, involving information acquisition, collaboration, planning and decision-making in a multi-agency setting. During the gaming-simulation, we employed multiple data collection methods. First, we interviewed participants on a team and a collective level using several plenary discussion sessions throughout both days. Second, we collected the individual experiences of the participants using questionnaires at the end of the gaming-simulation. Third, we asked the participants to return their logbooks that we had provided to them before the start of the gaming-simulation.

PHASE 5: EXPERIENCES FOR DASHBOARD DEVELOPMENT

The overall evaluation shows that the majority of participants was satisfied with the dashboards and intends to use these in practice (if they were to be deployed). The visual design of the dashboards was a particular point of appraisal. Moreover, the majority of participants felt the dashboard did help them prepare for the eventuality of a disaster. There were however several remarks regarding the definition of some PIs and their clustering in the dashboards. According to some participants, the dashboards were still “not tailored to their daily processes”. Based on these results, we gained the following three experiences for successful dashboard development.

Table 2: Experiences and tradeoffs in dashboard development

Experiences	Tradeoff	Explanation
1) Maximize stakeholder involvement in the PI selection and prioritization process	Speed of dashboard development process versus level of commitment	The tradeoff here is that involving all stakeholders in the dashboard development process might reduce the speed of this process since each stakeholder has its own goals and (technical) preferences. Yet, for gaining the commitment of the stakeholders for implementing the dashboards, it is crucial not to neglect the wishes of stakeholders who might lobby against the proposed dashboards.
2) Distinguish different levels of roles and their interest regarding PI	Generic dashboards for each role and organization or “one size fits all” dashboards?	The level of differentiation between dashboards was both important and problematic. Different levels of operators (strategic, tactical and operational) have different information needs, even if these are a combination on the same individual PIs. We decided to incorporate the different levels of disaster preparation in the dashboard architecture.
3) Enable users to easily personalize the dashboard representations on their own	The degree of GUI personalization by the user: fully customizable or non-customizable interfaces?	This particular tradeoff was very important for the software developers since they needed to know where to design “slack”. We decided to enable users to customize the style of visual representation (bar charts, graphs, numeric tables) with role-based, graphical views of key performance indicators depending on the types of data to be displayed (i.e., work flow management data, requisitions, payroll, human resources, and predictive applications).

Table 2 outlines three of the main experiences gained from the Aristoteles project. Even though these experiences may seem apparent, we opt for further research on their specification and evaluation. We discuss avenues for further research in the final section of this paper.

DISCUSSION AND FURTHER RESEARCH

The objective of this paper was to discuss our experiences from the development and use of dashboards for multi-agency disaster preparation. The development of dashboards is a difficult endeavor as it requires collective decision-making on design trade-offs and there is no universal recipe or benchmark for success. In such a setting, multiple relief agencies need to agree on the development of dashboards for disaster preparation. This multi-disciplinarity is one of the causes of a lack of standardization in terms of PIs, norms and data exchange formats. Since the number of academic contributions on dealing with these challenges is limited, little guidance is available to information system architects working on dashboard development for multi-agency disaster preparation.

We found that the difficulty in developing dashboards for disaster preparation no longer resides in the application of complex technologies or toolkits, since many platforms are now broadly available in the software market. Instead, two other challenges emerged in our work. The first challenge includes maintaining stakeholder commitment and designing dashboards that fit the level of understanding of the relief agency managers who need them. We argue that for dashboards to be effective, they need to be both aggregated yet tailored to the user role and context. However, tailoring the content of each individual dashboard appropriately requires a disciplined approach to the appreciation of the range of visual elements and the differentiation between the different types of dashboards. In addition, tailored dashboards also require designers to consider the context and environment of use together with the capabilities and goals of each relief agency manager. The second challenge includes the evaluation of dashboards, particularly in the context of multi-agency disaster preparation. It proved

to be difficult to simulate the processes, input and output of multi-agency disaster preparation because these were not yet clear in practice.

The gaming-simulation revealed that although we strived to formulate and visualize the PIs presented in a clear, concise, and goal-oriented way, the wrong interpretation of performance data remains a significant hurdle. The formulation and clustering of appropriate PIs in the dashboards proved to be a complicated challenge. Even though the employment of experienced relief agency managers did help in tailoring the dashboards, we opt for further research on the formulation, framing and clustering PIs for multi-agency disaster preparation. In addition, we encourage both scholars and practitioners to extend, apply and evaluate the experiences presented in this paper, allowing further theory building on the development of dashboards for multi-agency disaster preparation.

REFERENCES

1. Adam, F., & Pomeroy, J. C. (2008). Developing Practical Decision Support Tools Using Dashboards of Information. In F. Burstein & C. W. Holsapple (Eds.), *Handbook on Decision Support Systems 2* (pp. 151-173). Berlin Heidelberg: Springer
2. Baskerville, R. L. (1999). Investigating information systems with action research. *Communications of the Association for Information Systems*, 2(19), 12-18.
3. Boin, A., 't Hart, P., Stern, E., & Sundelius, B. (2005). *The Politics of Crisis Management: Public Leadership Under Pressure*: Cambridge University Press.
4. Carter, N., Klein, R., & Day, P. (1995). *How organisations measure success: The use of performance indicators in government*: Routledge, Taylor & Francis Group.
5. Clarke, S. (2005). Your Business Dashboard: Knowing When to Change the Oil. *The Journal of Corporate Accounting & Finance*, 16(2), 51-54.
6. Dover, C. (2004). How Dashboards Can Change Your Culture. *Strategic Finance*, 86(4), 43-48.
7. Duke, R. D., & Geurts, J. (2004). *Policy games for strategic management*. Amsterdam, The Netherlands: Dutch University Press.
8. Gitlow, H. (2005). Organizational Dashboards: Steering an Organization Towards its Mission. *Quality Engineering*, 17(3), 345-357.
9. Meijer, S. M., Hofstede, G. J., Omta, S. W. F., & Beers, G. (2008). The organization of transactions: research with the Trust and Tracing game. *Journal on Chain and Network Science*, 8, 1-20.
10. Morrissey, R. (2007). Tailoring Performance Dashboard Content. *Business Intelligence Journal*, 12(4).
11. Resnick, M. L. (2003). *Situation Awareness Applications to Executive Dashboard Design*. Paper presented at the 47th Annual Conference of the Human Factors and Ergonomics Society.