Group Decision Making in Emergency Response at the Port of Rotterdam

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Abstract
The Port of Rotterdam belongs to world's largest cargo and container ports. The potentially exposed area in case of an accident is about 600 square kilometers, containing about one million people. Emergency response at the Port of Rotterdam is a coordinated effort, involving five services: port authority, fire brigade, ambulance, police, and chemical experts. The commanders of these five services gather in an ad-hoc C3 center during emergency response. The objective of the research project reported on in this paper is to investigate whether and how advanced information and communications technologies (ICT) can improve group decision making in the ad-hoc C3 response center. There research should eventually provide answers as to the potential, advantages, and disadvantages of advanced ICT in group decision making at the Port of Rotterdam. Answers must also be found regarding the match between, and transition from, traditional C3 operations and a possibly new structure of an ICT-supported emergency response. In this paper we report on our preliminary findings stemming from evaluations of past accidents, interviews with commanders, and questionnaires from training exercises. The results of this preliminary study indicate that there is the need and demand for advanced ICT, and that careful coordination must taken place between ICT and traditional work approaches of the different services.

Keywords: training, emergency management, prototyping, decision support systems

1. Introduction

The port of Rotterdam in the Netherlands is one of the world's largest cargo and container ports. A large number of processing facilities and storage sites for hazardous materials are located within the port's perimeter, which covers about 600 square kilometers and contains about one million people (Figure 1).

The emergency response organization of the port of Rotterdam has developed a Regional Operational Base-Plan (ROB) to protect the physical and social health of the people living within and close to the port area. ROB is a product of industry, civil protection, and the port authority. ROB knows two major decision making authorities, the Command Place Incident (CoPI) and the Regional Operational Team (RegOT). CoPI consists of the commanders of the fire brigades, police, ambulance services, hazardous materials specialists, port authority, and a press representative. Their meeting facility consists of a mobile and specially equipped vehicle, which gets placed near the incident site. The head of CoPI is a fire brigade commander. Figure 2 shows a picture of a CoPI team during a training session.

Figure 1: Overview of the Port of Rotterdam.

2. Group Decision Making for Emergency Response

The decision making process for emergency management is defined in the Coordinated Regional Incident-Management Procedure (CRIP). CRIP is activated whenever at least one of the CoPI members calls for a coordinated response to any incident. CRIP has four coordination alarm levels (Figure 3). CRIP 1 involves activating CoPI. The port authority, fire brigades, police, hazardous materials specialists, ambulance services, and press work together in a multidisciplinary team with a fire brigade chief as the head of the seven-member team. CRIP 1 incidents are local and can be handled by the services provided by the CoPI members. CRIP 1 gets activated, on average, eight times each year.

If release measures outside the incident site are necessary, then CRIP 2 gets activated, and the RegOT gets activated. Emergency response is done on-site through CoPI but also through action centers. Both CoPI and the action centers coordinate the field units and report to RegOT. RegOT is located at the regional fire brigade; the members of RegOT are commanders of fire brigade, police, hazardous materials experts, ambulance, and port authority. RegOT reports to the administrative units, which have not been activated yet in full during CRIP 2. CRIP 2 gets activated, on average, four times each year.

CRIP 3 is activated if the incident calls for emergency response activities at the community level, where a full-scale RegOT gets activated. The response staff of the community where the incident originates (the source community) is activated and the operational activities are put on full alert. The population is being alarmed through sirens and the local radio station can be requested to act as the official information provider for the population. CRIP 3, which involves the whole command structure, was activated only once, in the past 40 years, namely in February of 1996, during the burning of calciumhypochloride near the town of Rotterdam.

Figure 2: Command Place Incident (CoPI) session in action.

CRIP 4, the highest alarm coordination level, is activated if the effects of a disaster cross the boarders of the source community. In this case, all the affected communities activate their response staff. The coordinating mayor is in charge to assure proper coordination among all affected communities. Each community has a representative of RegOT to coordinate the operational activities.

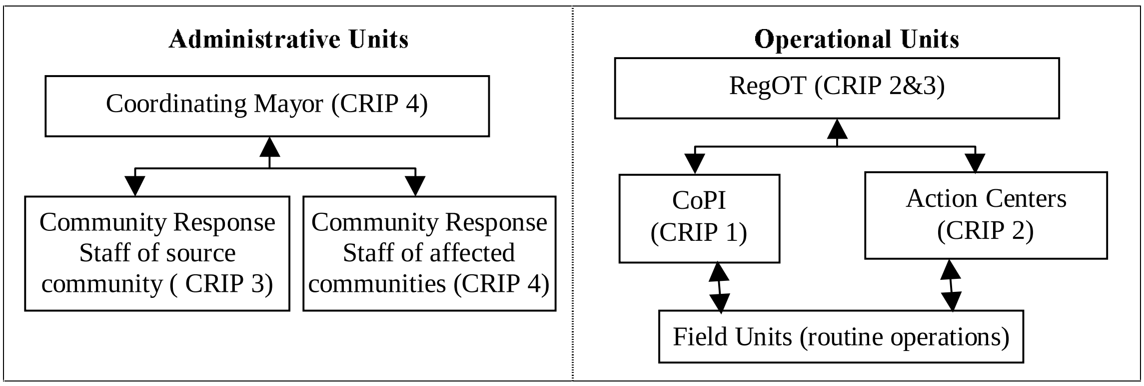

Figure 3: Activation of Coordinated Regional Incident-Management Procedures (CRIP) 1-4.

Incidents requiring the activation of a CRIP level occur infrequently, about twelve per year, mostly CRIP 1 and 2. One of the major concerns for the port authority is that this low frequency of accidents provides too little opportunity for the CoPI teams to gain experience if collaborative work, especially with respect to proper communication and decision processes within and across the CRIP levels. The decisions made by CoPI regarding command and control of the field units have traditionally consisted of activating standard operating procedures (SOPs). The complexity inherent in this four-level CRIP alarm concept, however, showed clearly the limitations of focusing solely on Sops. The current situation within CoPI is that the commanders of the five services gather, together with a press officer and a CoPI commander. Often, the activation of CRIP levels and of CoPI is not clear, and the start-up phase is characterized by a large amount of confusion. CoPI members join the team at different times, they have little familiarity with each other's internal procedures, and it takes too long for the communications channels to be established. Information availability is limited, and data access is restricted since the only communications channels are the telephone and the fax machine.

The port authority envisions a new CoPI system, which relies on advanced ICT [Bouters et al., 2001]. Knowledge and data should be easily accessible and transferable within and outside CoPI, and dynamic data should get updated automatically. The research reported on in this paper provides the basis of a design for such an advanced CoPI center.

3. Evaluation of Past Emergency Response Situations

A total of 16 incidents which happened between 1991 and 1997 were analyzed. Seven of these incident required the activation of CRIP I, eight of them required the activation of CRIP II, and only one required the activation of CRIP IV. The study of these incidents revealed four critical points.

1. <u>Incident start-up phase</u>: The start-up phase has been described in different instances to have been rather chaotic, because it took too long for each person and service to get an overview of what was going on. In some incidents, the CoPI was incomplete for quite some time. Information exchange and data acquisition took too long, with the result that the regular functioning of CoPI was delayed.
2. <u>Availability of specific information</u>: In many instances it took quite some time to figure out the types of hazardous materials involved in the incident. Weather data was often missing, which caused uncertainty to as to how to respond to an incident. There have even been report where this lack of data caused the fire brigades to use water where the nature of the hazardous material did not allow this.

3. <u>Communication</u>: Communication is an inherent problem in starting up a CoPI. Miscommunication between the services regarding the appropriate CRIP level have been reported. It was also found that faxes were never sent, time and location of measurements were miss communicated, and that communications is insufficiently updated.

4. <u>Knowledge</u>: During CoPI, there are many dispersed knowledge sources around; however, accessing these sources means often overcoming a high barrier. Services also showed to have quite some insufficient procedural knowledge. Divergent knowledge often leads to divergent assessments of alarm level. Finally, lack of mutual knowledge has led to a lack of complementarity of response tasks.

4. Evaluation of Interviews

A series of six interviews were held with selected experts in the field. Two interviews were held with two experts from the regional emergency response authority in Rotterdam-Rijnmond, one with a chemical expert, one with the police, and two with the port authority. The following findings can be reported:

-<u>Regional authority</u>

The regional emergency response authority is a cooperation between the fire brigades and the medical response organization. They are currently developing a joint effort and advanced ICT prototype system. The objective of this system covers very much the purposes of this project, namely to coordinate the work of different services, to automize vital procedures, to integrate multidisciplinary approaches, and to integrated advanced ICT systems, such as geographic information systems, expert systems, electronic meeting systems, etc. The critical point for such a system is that it has to accommodate work practices stemming from different service cultures. For example, the fire brigades use a different work approach than the medical response teams. However, if they want to use a joint ICT system, they must bridge their differences. An often cited example is the use of different terminologies, the different levels of working with computers, the different levels of knowledge, etc. An important aspect of making any ICT system for emergency response promising is to integrate it in everybody's daily work. It would be very inefficient to have people practice over the year for a system which might be used at most one or two times in a year. The use of the Internet was also seen as an advantage; however, experts of each service should be physically present at CoPI, and the Internet should link to additional experts at their headquarters. The CoPI members should also not be overwhelmed with the net ICT technology. To assure this, a new function could be enacted, such as a ICT specialist.

- <u>Chemical experts</u>:

The chemical experts have made a somewhat negative experience with an early IT system. The major complaints referred to the lack of automatic update of vital real-time data, such as wind direction, temperature, etc. Their conclusion was that the environment is too complex to be sufficiently automized in an ICT system. The automatic and rapid exchange of information between different services was seen as positive; however, there is danger of generating information overflow, which would be counterproductive to the purpose of ICT.

- <u>Police</u>:

The police have made also somewhat negative experience with the development of ICT systems. They contemplated that information should be updated automatically, since outdated information is seen as something worse than educated guessing. The use of IT by CoPI members was not seen as a fruitful approach, unless it is managed by an IT expert as part of an extended CoPI team. The negative experience made by the police with new ICT systems is that they have too many poorly projects going on, which have little cross-coordination. This was for them the reason not to start any new projects for the time being.

- <u>Port authority</u>:

The port authority has an overall positive attitude towards testing and implementing advanced ICT systems in emergency response. The main reasons are that important information gets updated automatically and that information retrieval gets significantly facilitated.

3. Evaluation of Trainings

The participants of the annual CoPI trainings were interviewed using a structured questionnaire. A series of 14 questions was asked to a total of 14 experts. The results of these interviews are summarized in Table 1. Reponses to the questions had to be scored on a scale from 1 (bad) to 9 (best). Table 1 shows that all but question 6 had a very high score. Question 6 indicates that a distributed CoPI setting, where the experts remain at their headquarters, is not seen as a viable approach. However, as the previously reported interview sessions revealed, it is very well desired that each CoPI member has Internet connection to its headquarters for further support in decision making.

1.(7.2) Advanced ICT improves CoPI activities
2.(8.0) Visual information improves CoPI/RegOT/GVS
3.(8.1) GIS improves CoPI activities
4.(7.4) Live visual improves CoPI/Reg/OT/GVS
5.(7.9) Advanced data bases improve CoPI
6.(5.5) Distributed CoPI via Internet
7.(6.9) Advanced ICT in start-up phase
8.(7.0) Human information manager in new ICT CoPI
9.(7.6) ICT improves relation CoPI - RegOT

Table 1: Responses from Questionnaire.

Table 1 clearly shows that the use of advanced ICT in CoPI has been assessed to have a positive effect, both within CoPI but also between CoPI and RegOT. An advanced ICT system should also contain visual information, animation, and especially real-time visual information about the development of the accident.

5. Outlook

The findings from this preliminary investigative work provide us the insights needed to plan the next step in our research, an experimental assessment. Figure 5 shows the envisioned layout of the CoPI, where the CoPI members can either communicate orally face-to-face in the room located on the right, or through ICT in the room located on the left.

We will use two fully equipped CoPI teams and two different scenarios. Our treatment for the experiment will be the two different approaches of external and internal CoPI communications. Method 1 consists of ICT-based external communication and oral internal communication, while Method 2 consists of full ICT communication. The response value will be effort and accuracy of the CoPI activities, which will be measured as time to accomplish the response tasks and quality of their decisions. A 2x2 Latin square design will be used for this purpose. The experiment will be conducted at the Port Authority’s headquarters in September of 2001. Experienced commanders will be the subjects of the experiment.

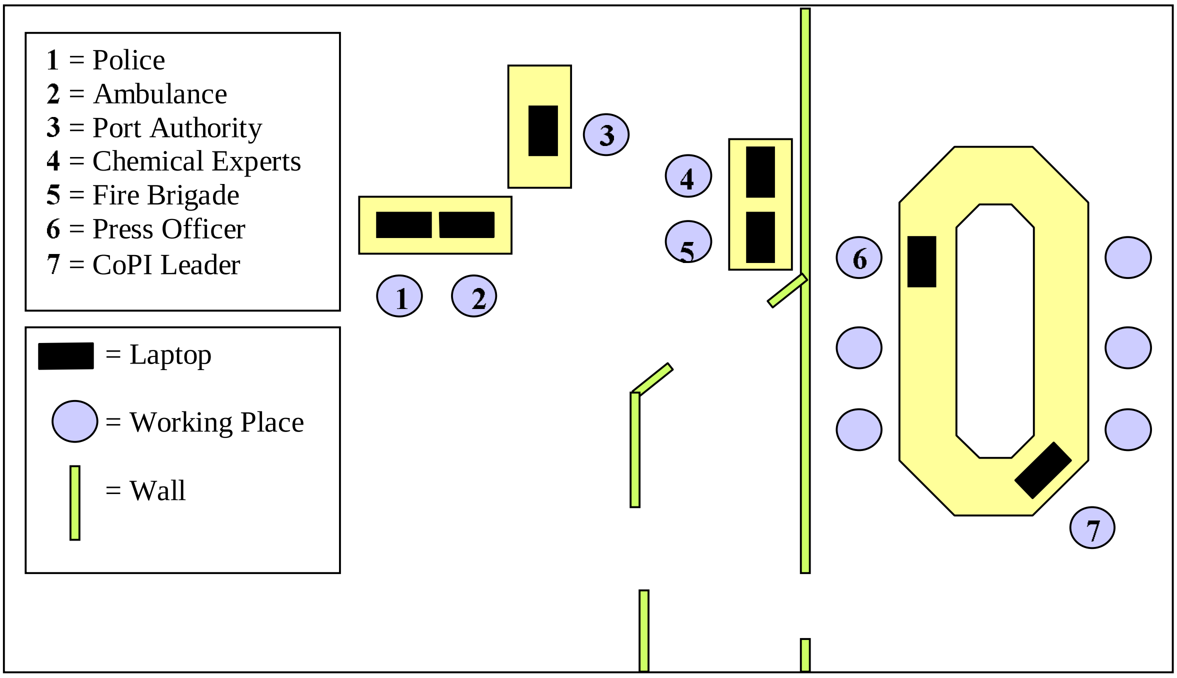

Figure 5: Layout of facility for experimental assessment.

6. Conclusions

The findings of this research clearly indicate that a new approach to CoPI, based on advanced ICT, is desired and necessary. However, there are clearly also potential downfalls of using advanced ICT in a group decision making setting in emergency response [Beroggi and Wallace, 1998]. First of all the ICT-based CoPI system must improve the decision making capabilities of each individual service. Moreover, it also must integrate the different cultures across the services. Finally, it must be integrated in the daily work of the officers, in order to assure their familiarity with the technology during the few cases that each officer is involved during the year. A clear answer as to which system layout has the most efficient impact on an advanced CoPI will only be obtained through an experimental assessment.

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Short Biographies

Marnix Bouwman works at the Port of Rotterdam on his M.S. degree in Systems Engineering, Policy Analysis and Management, Delft University of Technology.

Daan van Gent has ten years of experience as a preparation officer for the Rotterdam Port Authority and the harbor master's office. He is responsible for developing contingency plans, and for preparing and conducting education and training sessions.

Giampiero E.G. Beroggi is associate professor of policy analysis. He has taught classes in systems analysis, quantitative methods for problem solving, and risk management. His research deals with operational risk management, decision making, and conflict resolution.