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RIMADIMA
Risk-, Disaster-Management & prevention of natural hazards in mountainous and/or forested regions

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DEVELOPMENT OF CONCEPTS FOR DSS

- Development of a common concept of a „Decision Support System" for planning

- Development of a common concept of a DSS- emergency

- Definition of standard procedures for decision support systems used for risk management

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CONTENT:

Decision Support System

This document summarizes the work performed by SATA for the RIMADIMA in terms of concept, features and architecture of a Decision Support System (DSS) for the Civil Protection and the Journal of Events as support tool for information collection in the Crisis Management phase.

1. DSS for Civil Protection

The decision process life-cycle in Civil Protection is organized into five main phases, as depicted in Figure 1, two of which (green) perform preparatory activities, two others (yellow) perform operational activities, a nd the last one (brown) performs emergency activities:

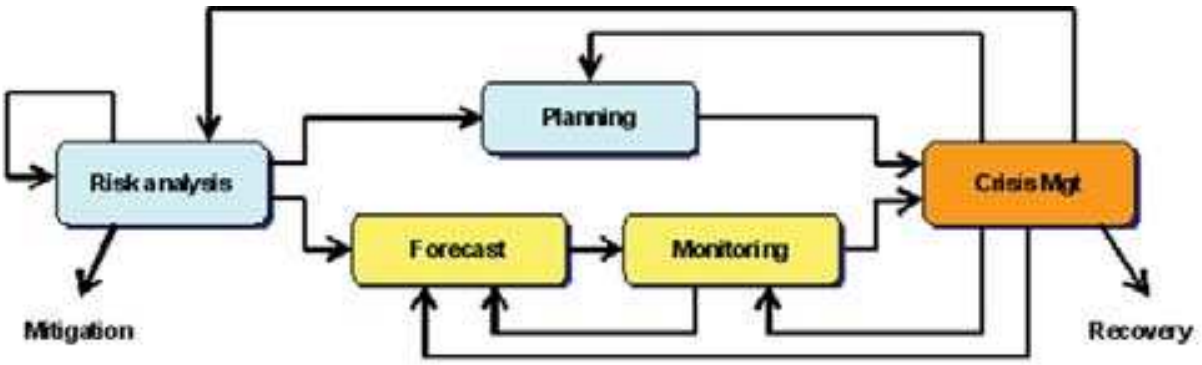

Figure 1 - Decision process life-cycle in Civil Protection

Risk analysis, to identify and evaluate risk scenarios. It also implies defining mitigation models related to the identified risks, periodically updating the risk scenarios, and elaborating on requests and hints coming form territory stakeholders.

Planning, to develop intervention plans and protocols for crisis management. It also implies projecting the intervention plans to the district and municipal scales and keeping feedback from territory stakeholder in due consideration when revising plans.

Forecast, to identify and focus on (probable) crisis areas and conditions. It also implies going deeper into evaluation of risks in critical areas, raising warning levels whenever needed, and providing indications to the Monitoring phase.

Monitoring, to keep the territory and its conditions under continuous control. It also implies performing validation and likelihood verification activities on collected data, and feeding the Forecast and Crisis Mgt phases before and during the emergency state.

Crisis management, to perform the right actions at emergency time. It also implies executing the foreseen protocols for con-trolled behavior of the involved actors, as well as collecting and making available relevant data to inform actors and document the performed actions.

Although differing by nature, objective, time scale and involved actors all of these five phases can take great advantage from using a DSS. Of course the contributions that such a DSS can give to the decision process strongly depend on the phase nature:

Preparatory phases (Risk analysis and Planning). The decision process is aimed at generating documents (scenarios, plans) by performing sequences of actions in

accordance with defined procedures. Each of the involved actors can be seen as a resource receiving a certain quantity/quality of information and working to enrich/finalize it for the next step.

Operational phases (Forecast, Monitoring). In these cases the decision process is aimed at selecting critical areas and applying measurement techniques to keep the devised risks under strict control. Parts of the decision points, especially in the Monitoring phase, are conveniently assigned to automata implementing proper analysis models.

Emergency phase (Crisis Management). In this phase the decision process is aimed at reaching the highest possible level of crisis interpretations as condition to undertake effective actions for population safety and damage limitation. To this purpose it is of paramount importance that each of the involved actors can perform at best the assigned activities.

1.1. Generalities

The "decision" concept ca be defined in many ways, e.g. "a choice between two or more alternatives based on estimates of the values of those alternatives". It can be taken by humans, machines or by their collaboration. In the last case we are in presence of a Decision emergency activities

In general a DSS is intended as "a computer-based tool or system to help humans in facing and solving weakly-formalized problems" and is made of four main components:

- User(s) for and about whom the DSS is built.
- Data management, to store and retrieve the domain data and documents.
- Model management, to represent dependencies and constraints and process data.
- User interface, to display and acquire information and human choices.

Depending on their main features DSSs can be classified as:

- Data driven, when they are requested to process wide time-series of technical data and reduce the information overload into synthetic indicators
- Model driven, when their contribution to the decision comes from the execution of simulation, planning or other kinds of formalized models.
- Communication driven, when they are explicitly conceived to favor the collaboration of actors by means of groupware or networking tools.
- Knowledge driven, when they show problem-solving expertise and capabilities with respect to the specific application domain.

Any DSS for the Civil Protection is mostly data and model driven (sometimes knowledge driven) and web based to cope with the geographic distribution of problems, actors and resources.

1.2. The Workflow Management paradigm

There are several reasons to justify the implementation of the Civil Protection DSS as a Workflow Management System (see www.wfmc.org), but two of them are particularly important:

The five phases are in fact carried out in parallel. This means that at a certain

point in time it normally occurs that there are several active initiatives belonging to the different phases, as sketched in Figure 2.

The human resources involved in the active initiatives are partially overlapping. Then it is worth managing all of them according to the same paradigm and paying particular attention to the concurrent use of such resources. In fact, a Workflow Management System is intended to model the process types that could be executed in each of the Civil Protection decision life-cycle phases and generate a process instance to be managed whenever its triggering condition is detected or communicated. Since then the Workflow Management System keeps track of the process instance progress in terms of activities carried out by the allocated resources and achieved results.

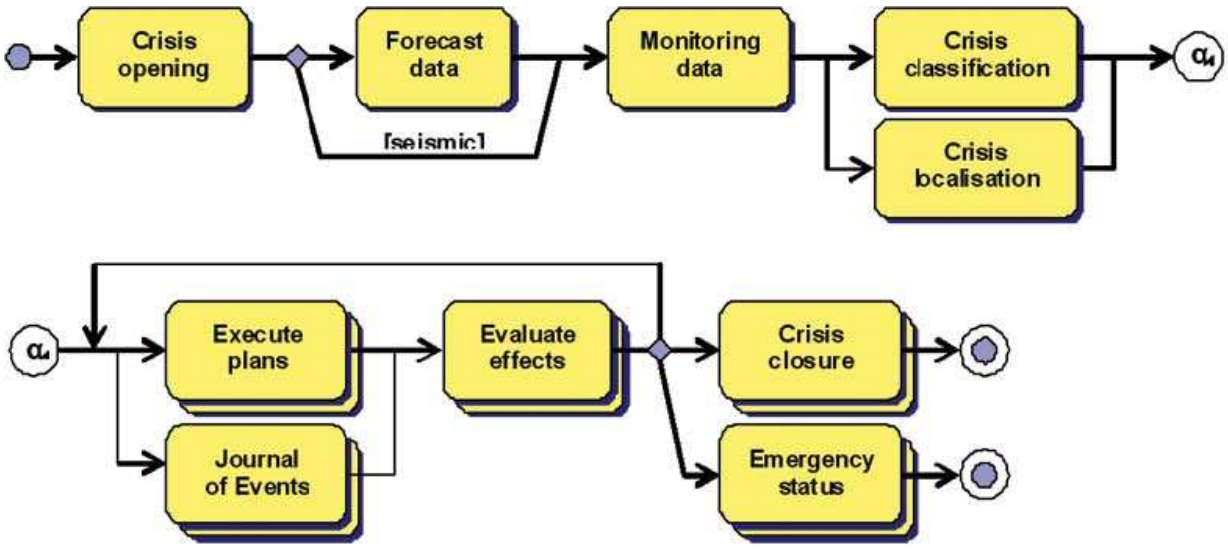

Figure 2 - Parallel execution of process instances belonging to different phases

In other words, adopting the Workflow Management (WfM) paradigm means representing the processes (procedures) characterizing the life-cycle phases in terms of component activities and their logical/temporal relations, and then driving and controlling the execution of each process by the allocated resources. In other words, the WfM approach is organized into two main parts to be respectively carried out at design time and at run time.

1.3. WfM - design time

This part of the WfM approach foresees the production of the following information for each modeled process:

- Process identification and assignment of its responsibility.
- Definition of its triggering conditions and/or events.
- Informal representation of its present organization (how things are managed now).
- Decomposition into elementary (atomic) activities.

- Representation of logical/temporal relations between activities (sequence, fork, branch, cycle).
- Coding of repeated groups of actions as sub-processes (routines). This design time task is strongly favored by the availability of a workflow graphic modeling language representing processes in a form like that reported in Figure 3.

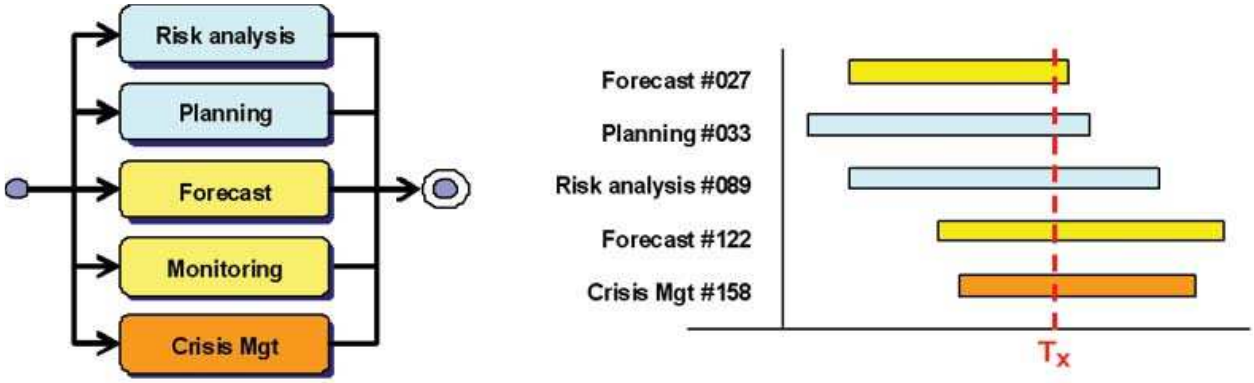

Figure 3 - Process modeling (example from Crisis Management)

After that, for every identified elementary activity the following information is represented in detail:

Activity name and identification code.
General description (informal).
Input and output data.
Generated / modified documents.
Tools / models to use.
Pre-conditions (if any).
Check-list of actions to perform.
Post-conditions (if any).
Actor in charge.
Average and maximum (acceptable) duration.

1.4. WfM - run time

The run time behavior of a WfM System includes an execution mechanism and a control mechanism:

- Execution mechanism. Whenever a triggering condition occurs the corresponding process is instantiated and the WfMS start applying its task assignment mechanism, as it is shown in the Figure 4 (left side).
- Task assignment is "neutral" since the WfMS has as main objectives the workload optimization to every involved actor and the possibility to know the execution progress of all the active process instances.

The single actor viewpoint is shown in Figure 4 (right side): the WfMS displays the list of assigned activities and the actor selects and executes them time by time.

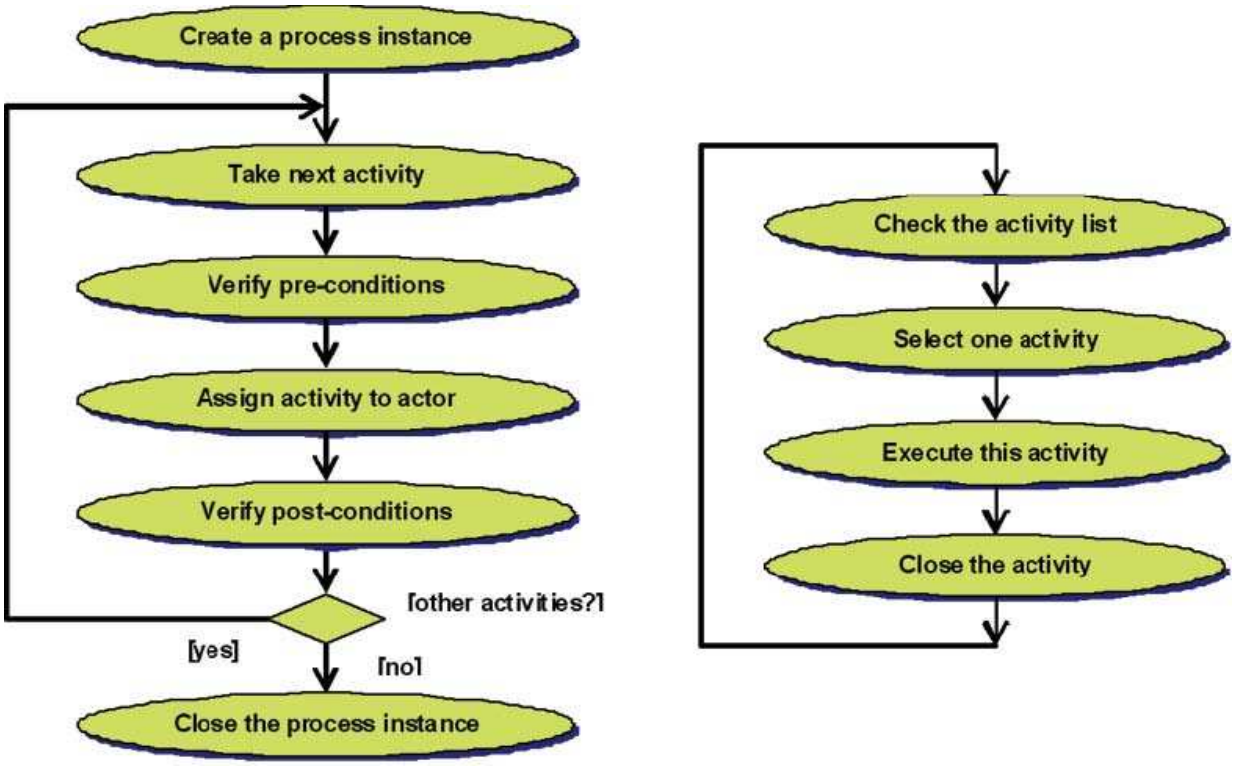

Figure 4 - Workflow execution: WfMS viewpoint (left) and operator viewpoint (right)

• Control mechanism. By tracking the activities performed by the different actors and storing the produced data and documents the WfMS is in condition to keep the entire decision process under control. In particular it can provide precise indications on the current state of the running process instances and details on the execution of the single activity and the behavior of the single actor.

2. Implementation of the Workflow Management System

The DSS for Civil Protection can be implemented as a Workflow Management System in different ways depending on the desired automation level. In short, there are three main levels to consider:

- ***Low level.*** Process modeling is in itself a value-added objective even if it is done for mere informational and organizational purposes, with-out activating automatic execution and control mechanisms. The value added by the design time part is the possibility, for the Civil Protection organization, to formalize and deeply understand the processes that are already executed as usual practices. Among other benefits this provides a stronger awareness of work done, employed resources, responsibilities and possible criticalities, to be taken as basis for process revision and improvement. Moreover, this is a sound basis for training newcomers and giving them an overview of the processes they contribute to perform.

- ***Medium level.*** Processes and activities are managed by a "manual" WfMS, meaning a task assignment and control function carried out by human responsibles. This function keeps record of the running processes and the assigned activities by establishing a continuous communication channel with the actors in charge. These are

simply asked to communicate start and end time of every assigned activity so as to let the control function to now the real progress of the running process instances and measure, to some extent, the overall sys-tem performances. This approach is preferable in the WfMS testing phase for it leaves wide margins to verification, organization revision and improvement.

- ***High level.*** Processes and activities are actually managed by an automated (ICT based) Workflow Management System. As a consequence the described execution and control mechanism are fully activated and every event or action is properly logged and used for system and individual performance evaluation.

This approach assures the maximum level of efficiency but can be adopted only in well trained and strongly committed work environments. In practical cases the preferable solution is a trade-off of the pro-posed approaches based on the following criteria:

- Process modeling as in the low level approach is always the first and most important implementation step. Gaining awareness on processes and decision points is the condition to introduce any kind of DSS and can be done with internal resources provided they are properly committed and trained.
- Manual Workflow Management is useful when the Civil Protection organization intends to undertake an explicit revision of current responsibilities and decision rules. The internal task assignment and control function becomes the new, formalized version of the previous mechanism based on established habits and practices.
- Automatic Workflow Management is practically useful only for those processes and activities, no matte if belonging to Risk Analysis or Crisis Management or other phases, whose criticality requires strict execution conditions and an explicit control. A smooth implementation should move progressively processes and activities from the manual to the automatic mode.

3. The Journal of Events

Going back to the decision process life-cycle, special attention should be put on providing the Civil Protection actors with suited ICT tools to support their activities. This is particularly important in the critical Crisis Management phase because of the strict time and operational constraints to meet and the number of decisions to be undertaken and actions to be carried out by a plurality of profiles acting in different sectors and places of the affected territory. Among the possible tools to support the Crisis Management phase the highest priority should be assigned to the development of what we can call the "Journal of Events" (or "Events Newscast") to collect and systematize the information com\ing from the territory about catastrophic event (as depicted in Figure 3 in parallel to Plan Execution). The reasons behind these choices are several, in particular:

The workflow of the involved actors and the decisions to be taken are strongly conditioned by the knowledge available about the current crisis. Then it must be concentrated into a unique point and made accessible in such a way to constitute a common reference for all.

The Journal of Events is substantially "neutral" since it can play its role (almost) independently of the nature and dimension of the catastrophic event, while any other support tool should probably be focused on a special type of problem.

Thanks to its "neutral" role the Journal of Events can be used even "at peace time" to manage daily problems of the involved actors, for instance to manage the regularity of the water supply network or to fix the malfunctioning of public services.

Its use "at peace time" is also a condition for the involved actors to remember its

functionality and user interface, and then to be ready for the Crisis Management phase when there will be no time to train people for its use. The Journal of Event was then realized and adapted to the RIMADIMA request to obtain as many localized versions as the participant regions (with translated both the user inter-face labels and the contents of dictionaries) and to obtain its integration with the RTE system for 3D navigation on the critical area. It was finally installed onto a personal computer of each of the project partners.

3.1. Journal of Events: features

The Journal of Events was designed and developed having in mind some very important requirements collected at potential users and managers of the Emilia-Romagna agency for Civil Protection, especially concerning the user interface, namely:

The user interface must be easy and intuitive so as to minimize the training effort and let users remember it fast in case of need.

Most fields must be shown already compiled with default information in order to minimize for the users the typing effort.

Most fields must offer pre-coded lists of items (dictionaries) among which the user is simply requested to scroll and select.

Approximate data are much better than no data; hence the system must be in condition to accept both detailed and rough information.

Lists must be easily sorted with respect to their contents, and it must be easy to move from a list item to its details and vice versa.

A log file must be maintained for tracing all the actions per-formed by the system users and then to go back to the history of a certain information. In addition, the Journal of Events presents a very simple logical organization based on three concepts: event, signaling and notification:

A (catastrophic) event is intended as the reason for a crisis. It is recognized by experts or by automata and entered into the Journal of Events as the root of a complex communication stage about its implications. In a certain moment there can be zero, one or more open (active) events and every communication refers to one of them.

A signaling is intended as the channel for certain information. Whenever information on a certain event arrives it is necessary to record first the way it was transmitted and collected. Once recoded the signaling data the user can associate one or more data received by that way.

A notification is intended as (one of) the contents associated to a certain signaling. In order to facilitate the user work, these contents are classified into different categories, namely:

- Damages, representing the final consequences of the event on the territory with special attention to antropic assets.
- Effects, representing the direct effects of the catastrophic event on the territory and, at the same time, the causes of the recorded damages.
- Requests, representing the needs for help and interventions coming from the territory through the signaling mechanism.
- Actions, representing the activities undertaken by the Civil Protection responsibles in consequence (or not) of received requests.

Moreover, the Journal of Events offers four further functions:

- Attachment. Every communication can be enriched by an unlimited number of attachments (e.g. photographs, maps, drawings, etc.).
- Correlation. The skilled personnel of the Civil Protection is put in condition to draw links between Effects and the consequent damages.
- Geo-reference. Every pre-coded place name has associated the geographic coordinates that can be used to select the relative map fragment or to activate RTE.
- Log file. As anticipated, all the actions performed by all the users are duly recorded and automatically tracked by the system. Further details can be found in the Journal of Events user manual now made available in Italian and English and then translated into several languages.