Towards a Performance Measurement System to Control Disaster Response

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Abstract. During a crisis, the main goal for decision-makers consists in restoring a stabilized nominal mode. The stakeholders have to face an important pressure and drastic constraints of response time and coordination. This study proposes a method assisting these stakeholders in their choices while carrying out a performance evaluation of the activities run during the crisis response process. Currently, in crises, the performance evaluation is only used subsequently due to difficulties in gathering and aggregating information into trustable performance indicators. The interest of this paper is to present this method which permits to obtain a relevant decision support system. Decision-makers will use it to resolve the crisis based on performance assessment. A case study about crisis management within the French Red Cross non-governmental organization is developed in order to explain how performance indicators can on the one hand support crisis response management and on the other hand improve the collaboration of stakeholders.

Keywords: disaster management; performance assessment; humanitarian organization process; indicators

1 Introduction

The topic of this paper is disaster management and in particular response to disaster. This issue, whatever the kind of crises, is topical. For example, “the increased frequency and scale of disasters, scarce resources, funding competition, and the need for accountability require more efficient, effective and transparent relief operations” [1]. During a crisis, the system leaves its nominal mode and the goal for the actors is to restore it. So stakeholders have to react quickly and have to deal with an important pressure and constraints of coordination from the stakeholders. It seems important to use tools to help the control to guide decision-makers in this phase. Currently, the actors implement a process of response with actions mainly based on their experience. Particularly in the case of humanitarian organizations intervening in disasters, best practices are developed from the report of results drawn up after each crisis. Thus, it enables them to elaborate a response to the crisis. This technique, which is based on experience feedback, is important because it is known that whatever the situation is, the capitalization of the data is useful. However, it does not enable a control of the response and has the following limits: it is not possible to make improvements to the

response process in real time because the actors assess the performance of their response process once the crisis is solved and enacting collaboration is difficult for the stakeholders due to the lack of formalization of the actions.

The reasoning suggested in this paper aims to guide the actors during the response. This paper presents a method which permits to create a Performance Measurement System (PMS) which will be used during the crisis. This new method, combined with the actors' expertise, helps the resolution of a crisis.

Firstly, section 2 presents a state of the art on performance assessment. Then, section 3 deals with the improvement of the control of the response to a crisis considering the performance assessment, lastly a case study will be exposed.

2 Literature review and problem statements

This section explains the performance assessment, and especially the implementation of indicators in time of crisis. That is why a short state of the art about the PMS is defined to see which are the methods used in this domain. The purpose of this paper consists in proposing a method to design PMS to support the management of the response in case of crisis. PMS are defined by a set of metrics and performance ratios, used to quantify both the efficiency and the effectiveness of actions [2].

2.1 Process Oriented PMS

In the literature several methods to create indicators are proposed. The mostly known are :

- The Activity Based Costing (ABC) method assigns costs to activities on the basis of their use of resources and then allocates costs to products according to their ratio of activity consumptions.
- The Holistic Process Performance Measurement System [3], or the Fraunhofer approach [4] develop the idea of PMS design based on business processes at the scale of an enterprise. Pertinence of Key Performance Indicators (KPI) is enhanced by the knowledge captured in process representation.
- The SCOR model [5] provides a unified representation of supply chains with five general processes: Plan, Source, Make, Deliver and Return. Each process can be refined in sub-processes, which are themselves decomposed into sub-sub processes. Three categories of KPIs are proposed in the SCOR model dashboard [6] depending on what they are related to: customers; internal processes and shareholders.
- The Balanced Scorecard where the indicators are given following four defined axes of performance: customer, finance, internal processes and growth.

According to these methods, the element which is interesting to retain is the cutting of the system in several axes and the creation of specific indicators for each axis.

So, it is necessary to determine on which level the assessment is made, i.e. to identify the several business processes which have to be monitored. (problem statement 1).

2.2 Performance and Decision-making Processes

A large number of PMS's methods link performance to decisions. We can quote for instance the Strategic Performance Measurement System [7], the Performance Measurement Questionnaire [4]; [8], the Strategic Measurement Analysis and Reporting Technique system [9] or the Cambridge University's PMS method [4]. They insist on the need to split decisions into many levels depending on their weight on the organization and their time effect. They also look for the sensitivity between KPI variations and alternative decisions by direct investigation. But if information on performance is condensed in KPIs, it is also possible to synthesize information on decision using the well known performance determinant, a concept first introduced by the Balanced Scorecard method (BS) [10]. The performance determinants have been natively defined as a control variable because one of the main criteria to select them is a sensitivity evaluation of their influence on the system. BS focuses on strategic management, and even if a reference to internal processes is proposed as an improvement policy, there is very little information about the method to do it. As previously said it is capital to set up KPIs to help actors concerning the most difficult decisions, *i.e.*. the most critical ones. So it is necessary to identify the most critical activities among all the activities of the system.

Thus we can wonder how to make this classification of the activities (problem statement 2).

2.3 Key Performance Indicators

Lorino [11] defines the performance indicator as an 'information that can help an actor, individual or more generally collective, to lead action towards the realization of an objective or can permit to evaluate the result of it'.

According to [12], [13], [14] and [15] the performance is the conjunction of several dimensions: relevance, efficiency, effectiveness, effectivity, responsiveness, flexibility and resilience. These dimensions constitute the key components upon which the subsystems of the organization in crisis shall be evaluated. According to the situation, several dimensions can have more importance.

So, in case of disaster, it is useful to determine the dimensions which will predominate (problem statement 3).

Once the indicators are created, it is necessary to begin the measurement process at a defined frequency. The performance measurement is an observation of the state of a system. It is the reflection of the real state of the system, given by indicators [16]. Once the measurements are made, they are compared with the objectives to obtain the performance assessment. After the assessment, improvements can be made if the performance is not satisfactory.

3 Designing the Crisis PMS

The meaning of the word *crisis* differs from a field to another. In the literature, two words are used to describe this concept: crisis and disaster. "Usually, crisis is

considered as man made and a disaster as a natural phenomenon" [17]. In this paper these two words are used equally, in general context. However, during the description of the case study, the term disaster is used.

A crisis can be defined as a complex and dynamic phenomenon, which constitutes a threat for the survival of an organization and its members, which gives short time to react and which leads to an adaptation of the system [18]. This definition underlines the fact that it is necessary to make decisions in emergency. However, it introduces a new element: the dynamic aspect of a crisis. A crisis situation is rarely fixed, it changes all the time. Obviously, its management is made more difficult. This study is focused on sudden crises, *i.e.* we do not deal with pandemic or durable economic crises, for example.

Based on Alexander's cycle management [19] and on literature review, the disaster management cycle is composed of: prevention, preparation, response and recovery. Our study concentrates on the third phase: the *response*. It integrates all the actions to be carried out as fast as possible after an impact such as for example the release of the emergency plan or the evacuation of a threatened population. At this level, the main aim is to set up actions acting on the system in crisis in order to bring it back to a normal situation as soon as possible.

The goal of this study is to implement a method during this phase, which will help the decision-makers in their management, based on PMS. This method will permit to make readjustments in real time in the management of the response.

The method is then detailed, to answer the three principal problem statements evoked previously. It is composed of three steps.

3.1 Step 1: on which level is the assessment made?

The creation of indicators of performance implies an analysis of the organization to determine on which part the assessment must focus. Each group of response's actors has its own objectives and thus it is necessary for them to have specific indicators. So that our method can apply to various types of crises, a 'standard' cutting of the organization which manages the response is chosen. Based on the generic structure described by [20], generic business processes concerning the response phase has been defined. In fact, some domains, specific to crisis management, have been added or adapted to the Porter's structure, based on NGO reports. Thus a map for the response process has been defined (see figure 1).

To model the different parts of the response system, we have used the Business Process Management concept, according to the rules of standard ISO 9000 – 2000.

The map in figure 1 shows three levels of processes:

- *1st level: operational*:

In this level, the *evaluation* takes place at the beginning of the response. There are processes for the preparation and processes for the field.

- *2nd level: management:*

The *study* permits to validate the importance to start an intervention. Then there is a process which describes the field management and another which explains the preparation management. There is also a unit to coordinate these ones and to manage collaboration with other stakeholders. At least, a process is devoted to the *a posteriori*

performance assessment, which permits to draw up reports on response and make feedback.

- *3rd level: supporting*:

Human and material resources and information systems are put at disposal. There are also financial aspects and activities of communication.

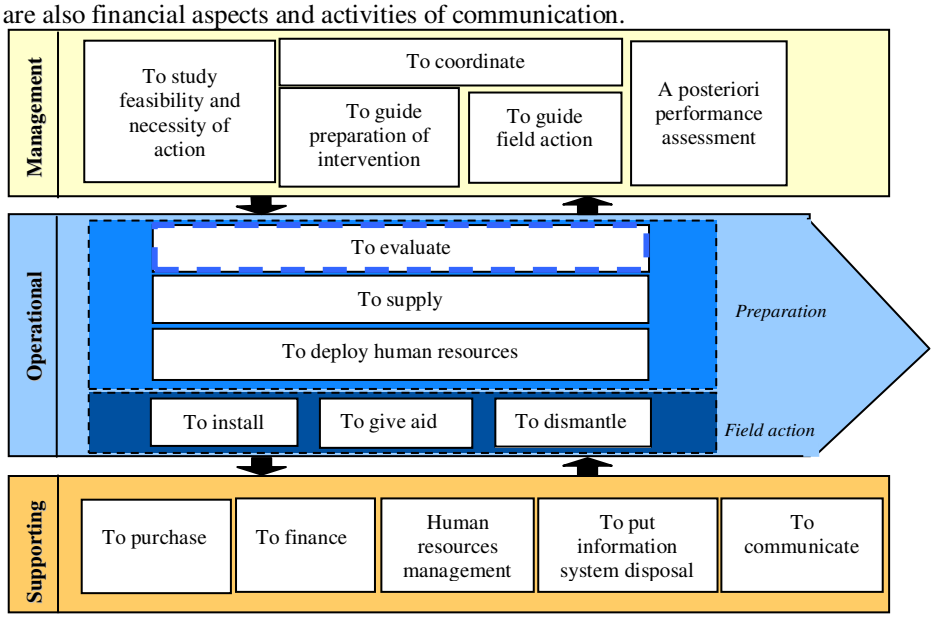

Fig.1: Map of response process

The highest decisional level: the strategic level, is thus divided in three main domains (i.e. Supporting, Operational and Management). Each domain is composed of processes which represent the tactical decisional level and finally each process is made up of activities, not detailed at this stage, which are the operational level. Thus according to the decisional level at which the user wants to place himself he will choose to install indicators for the domains, the processes or the activities.

We depicted at which place the indicators could be positioned. Let us now explain how the most important processes which have to be monitored are selected.

3.2 Step 2: selection of processes thanks to a risk analysis

Our study is led in a context of crisis, the time factor is thus essential, so it is necessary to limit the critical activities which could slow down the progression of the response, directly by causing a waste of time or indirectly by generating errors whose resolution would mobilize too many resources. That is why it seems more relevant to put indicators on the less reliable parts of the system. Thus, we will propose a risk analysis, based on the FMEAC method, in order to index the most critical processes and to supervise their realization with the indicators. This method consists in defining the causes and the consequences of a studied risk while calculating its *criticity* which is the product of *gravity* by *detectability* by *occurrence*. If the result exceeds a given threshold, the risk is considered as critical. According to the kind of crisis it is

possible to attach more importance to one of the criteria, for example gravity for a natural disaster. The goal is to determine the most critical activities to treat them in priority. This stage is important because the indicators which will not be positioned on tactical places will not be useful. Moreover it is important to keep only the most critical risks in order not to have too many indicators to manage.

3.3 Step 3: the creation of key performance indicators

For each critical activity, it is necessary to determine one or more indicators of performance. These indicators are characterized by a name which describes what the indicator measures, by a formulation which shows the calculation to be done to obtain the result and finally by a class.
In order to define indicators, the stakeholders use their expertise and international organization's database.
The indicators created are selected and indexed in a summary table (see example in table 1) in order to facilitate their use. The classes are the different dimensions of performance, described in section 2.3. Each indicator is associated with a class in order to know what component of performance the indicator is measured. In case of disaster the most frequent dimensions are effectiveness, responsiveness and resilience.

4 Case study

The case study chosen is an earthquake. The method seen before has been implemented on the case of this disaster. Our study has been focused on the humanitarian organization's response phase.

For this paper, a focus is made on *evaluation* process (see details in figure 2).

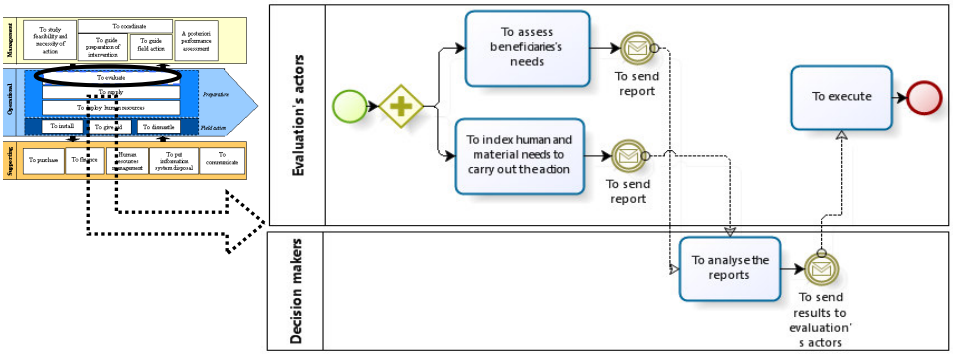

Fig.2: Process: evaluation of means

Two kinds of evaluations must be differentiated:

- the evaluation of means consists in determining the human and material resources that are necessary in the place of the disaster and in which quantity,
- the determination of the suitable kind of response: this assessment is made once the accessibility of the place is determined. It consists in defining which are the

means usable for the procurement and movement to the place of the disaster and their quantity.

In this paper only the results for the process *evaluation of means* are detailed (see table 1). According to the method, once processes are defined it is necessary to carry out a risk analysis. The scale of points used for the criticity runs from 1 to 9 and the threshold is 100 points. If a risk obtains more points: it is critical so an indicator has to be set up on the process concerned. This work is summarized in table 1.

Table.1: Results obtained for *evaluation of means*.

Process: Evaluation of means						
Risks				**KPI**		
Names	**Causes**	**Consequences**	**Criticity** D x G x O	**Name**	**Formulation**	**Classes**
Slow evaluation	Bad organization of estimation	Waste of time	6 x 9 x 3 = 162	Cycle time	1-Days between the beginning of crisis and appeal	Responsiveness
Error on the assessment of needs	Pessimistic estimation: too many means requested	Waste of means	6 x 9 x3 = 162	Coherence between orders and needs	2-Number of items asked (order)/number of items requested (crisis area)	Effectiveness
					2.2-Ref. asked (order)/ref. requested (crisis area)	Effectiveness
	Optimistic estimation: not enough means requested	Lack of means	9 x 9 x3 = 243		2.3-Number of means asked (order)/number of means requested (crisis area)	Effectiveness

The evaluation is essential. It should not take too much time as the response process would be slowed down. However it must be carried out seriously because errors of estimation can have serious consequences on the continuation and reduce the effectiveness of the response, in particular as regards supply chain.

5 Conclusion

Because of the increase of crises, it is necessary to have tools to manage a crisis response as correctly as possible. This paper presents a method which gives an assistance to crisis management. It shows how to control the phase of response to a crisis by the performance. Thus, after a state of the art on crisis management and performance assessment, we have presented a modeling of the response process for a crisis. According to this method, to carry out a performance assessment, it is necessary (1) to know what has to be evaluated *i.e.* on which processes the indicators will be set up, (2) how the processes to monitor are selected and (3) how the key performance indicators are defined. The method has been applied to a case study: the humanitarian organization's response to give an example of key performance indicators which can be defined thanks to our method.

The main perspective is the implementation, on the field, of tools to apply this method at the strategic, tactical and operational levels of a humanitarian organization.

The French Red Cross organization has been already contacted in order to validate the relevance of this method.

Then, the second field that will be investigated is an extension of this tools to industrial sectors.

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