Maturity model-driven assessment of Field Hospitals

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Abstract: Mobile field hospitals are set up urgently to respond to all types of emergencies and to meet the health needs of people. In this case, field hospital must be efficient and respond accurately to the emergency for which it is deployed However, this efficiency can be observed only when the field hospital is deployed during the emergency. Therefore, any deficiencies can not be corrected "*on the fly*" to fully respond to the emergency. As a consequence, it is interesting to assess the field hospitals before their deployment to ensure it is able to respond efficiently to the emergency. This paper focuses and illustrates the first development to assess a field hospital and based on maturity model. This work takes place within the collaborative research project "HOPICAMP", funded by the French Unique Interministerial Fund for a new generation of field hospitals

Keywords maturity model, field hospital, maturity levels, maturity assessment, axis of interest, emergency.

1. INTRODUCTION

The emergencies caused by disasters (wars, climate, epidemics.) are characterized by a to al mess The suppor to the victims must be fast and effic ent, the first hours post disaster are generally the mos valuable. To respond to the emergencies, medical resources are deployed AMP (Advanced Medical Post civil security) or PSM (Post Sanitary Mobile), are referred to routinely as "**field hospita s**" (PAHO *et al.,* 2003) Their operators are multiple (civilian, military, NGOs) and their capabilities and functioning are somewhat standardized (Canadian Red Cross, 2014).

Field hospitals aim to supply local health structures which can be insufficient in crisis conditions. A f eld hospital is primarily (1) a medical team (doctors experienced nurses) and (2) the conditioning of medical equipment to be easily transportable. Field h spitals target four main missions (PAHO *et al.,* 2003) (Nortan *et al ,* 2003):

1. The triage of victims or serious related emergencies;
2. The identification of victims by developing a medical card called "forward ;
3. The care for serious victims;
4. The organization of evacuations according to priorities and availability of hospital.

However, in a real emergency situation, a field hospital faces up some limits such as: mismanagement of the organization, logistics, and lack of communication with the authorities of the disaster country… Faced with the many l m tations of these s ructures he HOP CAMP project at emp s to develop a set of innovative solutions to optimize emergency care and offer an integrated solution for a new g neration o fie d hospital. In this way, the objective of this research work is to propose good practices and ecommendations to improve the deployment of a field hospital thanks to the concept of maturity model. The here presented research is validated by the team of ESCRIM[1], the field hospital deployed by France. I is managed by the Departmental Fire and Rescue Service of the Gard region (SDIS[2] 30) and the Civil Security Instruction and Intervention Unit 7 (UIISC7[3]). The effectiveness of its rollout depends not only on the medical services provided but also on other aspects such as, for instance, the logistic, the management of resources and its ability to work with other organizations.

After this brief introduction, the context of this research is pr ented through the prism of field hospitals in disaster response. The third section presents a short survey regarding to some matur ty models in health domain. Section four presents the proposed structure of the Field Hospital Maturity Model (FHMM). After, section five shows the way on which

[1] Elément de Sécurité Civile Rapide d'Intervention Médicale : http /www escrim.org/
[2] Service Départemental d'Incendie et de Secours
[3] Unité d'Instruction et d'Intervention de la Sécurité Civile

this proposed maturity model is validated. Finally, a conclusion is given section six.

2. FIELD HOSPITALS IN DISASTER RESPONSE: STAKEHOLDERS' REQUIREMENTS

An emergency is a situation that poses an immediate risk to health, life, property, or environment. Most emergencies require urgent intervention to prevent a worsening of the situation (UK Government Advice, 2007). To face the emergency situation, some governmental and non-governmental organizations offer medical solutions among which, the **field hospitals**. A Field hospital is defined as: "*a mobile, self-contained, self-sufficient health care facility capable of rapid deployment and expansion or contraction to meet immediate emergency requirements for a specified period of time*" (PAHO *et al.,* 2003). These hospitals are deployed in few days and provide the services of a common hospital on the site of the emergency until local medical facilities are able to manage the patients flow. The decision to deploy is related to the context, the nature and the intensity of the emergency event. Hence, a rapid assessment of needs, capacities and vulnerabilities is critical for an appropriate and a customized response. Furthermore, disasters create chaos; therefore, to maximize efficiency and to provide the best emergency care to the local population, coordination and collaboration efforts are required. However, in a real situation, these goals are often partially or not reached (Canadian Red Cross, 2014).

For instance, the earthquake in Haiti in 2010 caused many deaths and wounded. Due to the intensity of the event, several countries and organisations have sent aids to help the population and support local authorities. The most important support was coming from field hospitals. Indeed, a total of 44 foreign field hospitals were sent on an assignment from different countries (Nortan *et al.,* 2003). However, problems have been highlighted in relation to the deployment of these field hospitals. One of these problems is related to the gap between the real needs, on the spot, and the needs assessed in terms of capacity and skills before deployment. A second problem to mention is related to the coordination mechanism between the various field hospitals which find difficulties with teams that are not accustomed with international emergency response systems and standards (Nortan *et al.,* 2003).

Consequently, inexperienced teams can be unable to provide the best help for local population. The quality of preparedness strongly affects the response time and effectiveness. For these reasons, a field hospital must achieve a minimum standards and effective response to disasters. To support and guide the achievement of an optimal response to an emergency situation, the here proposed research aims to make available:

- A reference model (maturity model) that identifies and defines precisely the aspects that play a crucial part in the deployment of a field hospital namely "axes of interest".
- The means to measure each axis of interest to have precise vision of the strengths and weaknesses of the studied field hospital.
- A set of recommendations that guide and give the best practices to improve each axis of interest.

At the end, an approach will also propose to guide end-users to use the proposed model. This approach will define: (1) steps to follow, (2) actors who lead the evaluation and (3) sequences between steps in order to implement the maturity model and get evaluation in coherent manner. The final purpose is to provide a full methodology allowing to use the model properly and to improve field hospitals (Fig. 1).

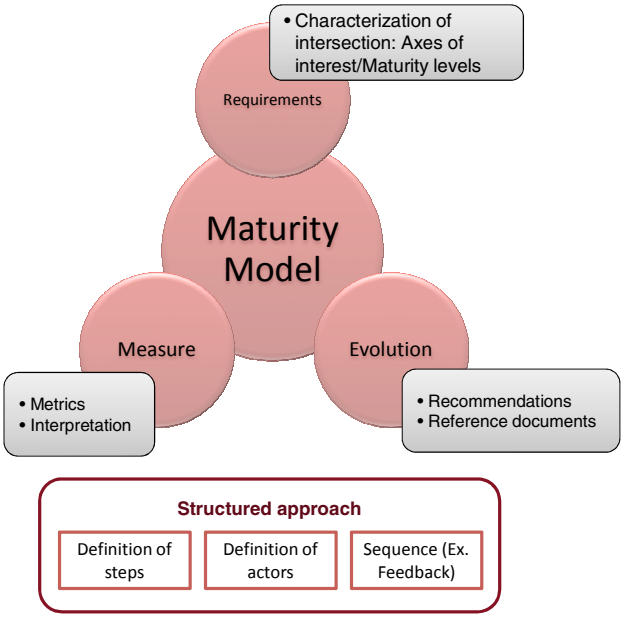

Fig. 1. Big picture of the methodology to support field hospital evaluation.

3. MATURITY MODELS IN HEALTH DOMAIN: STATE OF THE ART

A maturity model includes levels consisting of a predefined set of axes of interest. These levels are measured by the achievement of the specific and generic goals that apply to each predefined set of axes of interest. Furthermore, a maturity model provides recommendations and practices to evolve throughout maturity levels for continuous improvement and the achievement of full maturity regarding the axes of interest (adapted from CMMI, 2002). The maturity models were introduced in the 1980s with the development of *Capability Maturity Model* (CMM) (Paulk *et al.,* 1995). Among numerous existing maturity models, let mention the popular *Capability Maturity Model Integration* (CMMI, 2002). The starting point of the proposition of such maturity models was based on the need to know the status of multiple existing IT projects. Indeed, these maturity models are dedicated to evaluate project management through the control of processes in enterprises. From these initial models, numerous models was built up and, currently, maturity models are developed in different fields such as Information System Interoperability (C4ISR, 1998), Enterprise Interoperability (Guédria *et al.,* 2013), Enterprise

Architecture (NASCIO, 2003), and represent an accurate mean of evaluation with several advantages such as:

- **Self-evaluation**, a maturity model can be used directly by the end-users to assess their structures according to the considered point of view;
- **Easy to learn and to apply**, a maturity model does not require specific training;
- **Reduced delay** to get an accurate analysis of the considered system;
- **Precise recommendations** and path to evolve progressively through the maturity levels.

Regarding maturity models dedicated to health, the Healthcare Data Quality Maturity focuses on the knowledge of the level of Data Quality within a hospital. It is considered that it is possible for the medical errors to be related, directly or indirectly, with the level of Data Quality (Pinto-Valverde *et al.,* 2003). The Health Usability Maturity Model supports health leaders and individuals to assess their levels of usability and then move toward more advanced levels (Staggers et al., 2011). It exists another model such as the *Business Intelligence Maturity Model for Healthcare* which contributes to information and knowledge management in healthcare (Brooks *et al.,* 2013). These maturity models are dedicated to health for organizations such as hospitals or clinics. However, they do not take into account the emergency aspect that characterizes the nature of a field hospital.

In this way, numerous works related to field hospitals are available. These works offer standards and applicable documents describing requirements that a field hospital must satisfy to respond efficiently to an emergency situation. The most known, is probably the Emergency Medical Team developed by the WHO (World Health Organization) (Nortan *et al.,* 2003). The main goal of the WHO is the coordination of the international response to emergency situations. To this aim, this document classifies care on three levels using 21 criteria such as hospital accommodation capacity or else, the type of surgery carried out. It also gives general guidance on standards for logistics. Furthermore, the major NGOs (Non-Governmental Organizations) have their own guidelines regarding to some aspects of the organization of a field hospital (Tertrais, 2011). For instance, the MSF[4] Guidelines (Noorgate *et al.,* 2010), Red Cross guidelines (CICR, 2011), WHO guidelines (Chartier *et al.,* 2014) and the Sphere Project (The Sphere Project, 2011) provide guidance to manage, in particular, the medical and domestic wastes and the use of water. These works are related to a specific part of the deployment of a field hospital, especially on care area. Hence, these works do not lead the global organization regarding, for example, human resources management, equipment management, economic and environmental impacts, logistics… As a consequence, it is proposed to elaborate a maturity model and associated tools for field hospitals whose primary developments are given in the next section.

[4] Médecins Sans Frontières

4. THE FIELD HOSPITAL MATURITY MODEL (FHMM)

4.1 Founding principles

Improving the proper functioning of a field hospital require to have a list of criteria that characterizes its functioning as complete as possible, sufficiently formalized to be evaluated and highlighting relevant axes of development to favour. In this way, developing a maturity model can be an efficient solution. In the case of the HOPICAMP project, the proposed maturity model for field hospital is based on several existing works/documents (Fig. 2.) that means:

- Existing documents describing **Field hospital** structure and organisation such as the ESCRIM (Mailhac, 2016), French field hospital.
- Existing **guidance** for field hospitals especially the EMT (Emergency Medical Team) developed by the WHO which offers a global classification of field hospital regarding care response (Chartier *et al.*, 2014). The EEMC (European Emergency Response Capacity) gives a grid for the certification of field hospital[5]. INSARAG (International Search and Rescue Advisory Group) guidelines are intended as a reference guide for international urban search and rescue operations (INSARAG, 2012). These guides provide criteria to develop a maturity model.
- **Other** existing related works such as maturity models (CMMI, 2012) that can be used for the logistic aspect of field hospital. Another document can be used to build the proposed maturity model: the Sphere Project (The Sphere Project, 2011) which frames a Humanitarian Charter and identifies a set of minimum standards in key lifesaving sectors.
- The used and applied **standards/norms** in the country, in which the disaster occur as well as the standards/norms used and applied by the country in charge of the deployment of the field hospital must be considered to respond efficiently to emergency situation with techniques that are experienced.

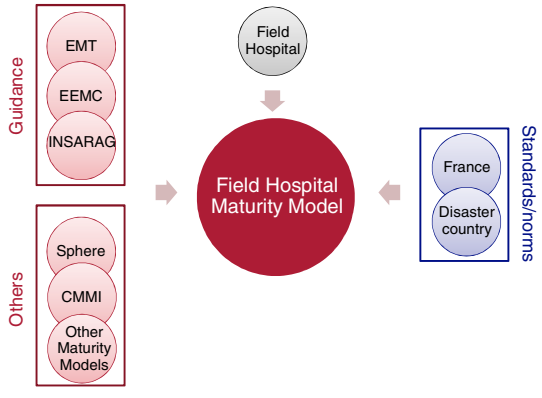

Fig. 2. Construction process of Field Hospital Maturity Model.

[5] http://ec.europa.eu/echo/what-we-do/civil-protection/european-emergency-response-capacity_en

Lastly, the construction of the maturity model is based on the very first structure presented in (Daclin *et al.,* 2016). Indeed, the structure of this first model is extended and reorganized, taking into consideration the structure of a field hospital for better consistency as indicated below. 4.2 Structure of the maturity model

The structure of a field hospital may differ from one country to another and from one organization to another. Nevertheless, whatever the structure and based on systemic theory - enabling to grasp a system under different points of view - (Le Moigne, 1977), a field hospital must consider the logistic (support aspects) medical (business aspects) and governance (decision-making aspects) facets (Fig. 3).

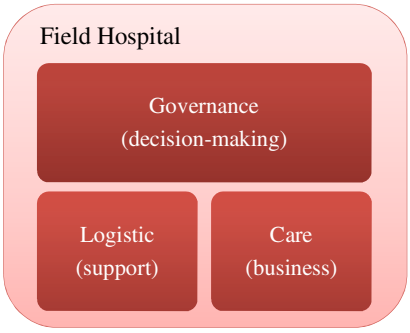

Fig. 3. Overview of a field hospital structure.

From this first structure, the maturity model proposed is based upon a **global model** including three main axes of interest themselves developed by 3 **local models**, as shown in Fig. 4.:

- **Governance:** it refers to the decisional aspect of the field hospital during its mission with the consideration of critical point to consider during the whole lifecycle of the mission such as the situation assessment, the deployment, the operation and the withdrawal.
- **Logistics:** it refers to the supply, storage, transport and the collect after use on site of all means used by the field hospital (medical and non-medical). The logistic can be ensured by internal or external organizations.
- **Care:** it refers to the medical services (care) provided by the field hospital during its mission.

These 3 axes are composed of the set of key points. These key points were identified and placed on the maturity model after a bibliographic study, as shown in Fig. 2, and interviews with stakeholders (mainly SDIS 30). This granularity level allows (1) to gain in reading of the whole model (*e.g.* safety and security, waste management) and (2) to gain in precision for a future measurement. Indeed, the better the measurement, the better the identification of weak point and the recommendation

Each axe presented previously is characterized by the 5 levels of progression enabling an accurate assessment of maturity and defined such as (Daclin *et al.,* 2016):

- **Unconsidered/unknown:** this level represents a poor (or in worth cases no) consideration of the axis of interest.
- **Initial:** The axis of interest is known and considered in a rudimentary and ad hoc manner.
- **Practiced:** axes of interest are known and considered. However, no monitoring or assessment of axes of interest is done.
- **Managed:** the axes of interest are considered by international standards and existing procedures. They are monitored and managed according to a standard/own indicator system.
- **Improved:** The axes of interest are continuously improved. Each change in procedures/ standards… is considered, recorded and performed.

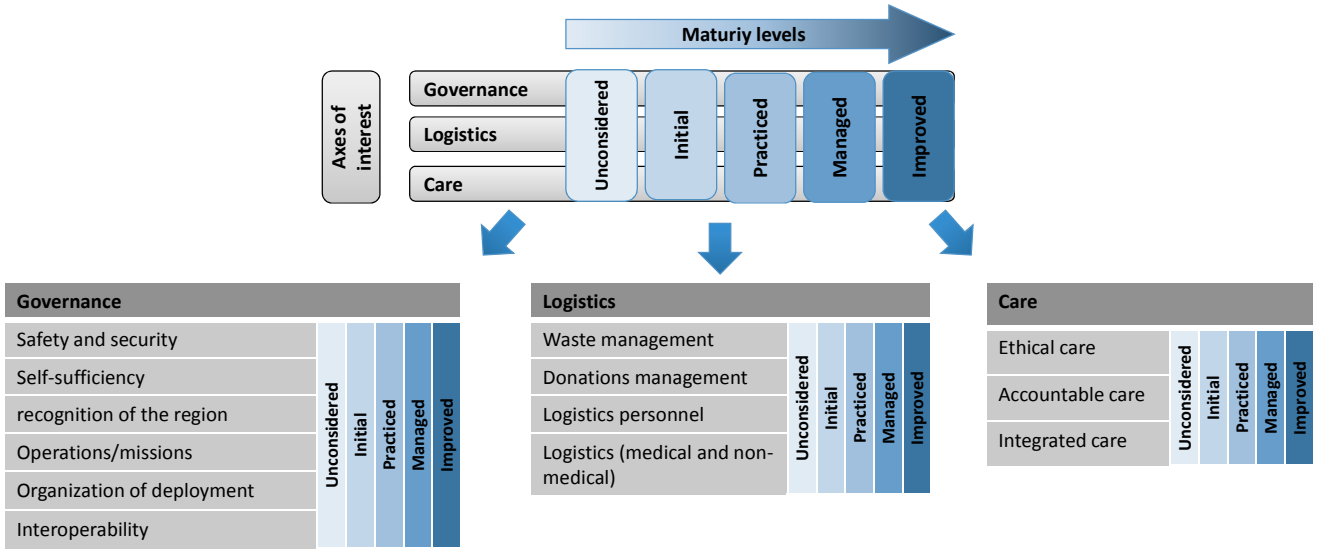

Fig. 4. Field Hospital Maturity model.

Intersection between axes of interest and maturity levels gives requirements to satisfy to achieve the desired maturity level. As a consequence, each intersection in the model has to be defined precisely in order to characterize the maturity levels. It is on the basis of the levels that maturity can be evaluated. Thus, the definition and the filling of the Field Hospital Maturity Model relies on the analysis of the documents such as guidelines, other models and standards related to the domain as presented previously in the construction process (See Fig. 2.).

4.3. Maturity measure and recommendations: first proposal

The assessment is essential at each maturity level to have an accurate view of the strengths and the weaknesses regarding to axes of interest. The measure provided by the Field Hospital Maturity Model is based on the satisfaction (or not or else partially) of requirements that define each level. However, the measure of a maturity level is not only related to the satisfaction of a set of requirements, it depends also on the context in which the mission is located. For instance, an interoperability requirement such as: "*ability to work together with other modules and teams*" will have no meaning in the case where there is only one field hospital deployed in the area. Therefore, interoperability with other teams is no longer required. In this case, some requirements may, for example, be neglected and their satisfaction is no longer required to achieve a certain maturity level. Thus, the local measure of maturity, in terms of Governance, Logistics and Care depends, first, on the satisfaction of requirements and, second, on the context in which the field hospital is deployed as shown (1).

$$M_L = f(R, C) \quad (1)$$

With: M_L: the local maturity $\in$ {Governance, Logistics, Care}

R: Requirements of each level.

C: Context of the mission.

In this sense, the evaluation is only considered at a local level (each axis of interest is evaluated independently) and it could be interesting to consider the maturity evaluation at a global level, *i.e.,* to get a global maturity indicator coming from the aggregation of each local evaluation as in (2). Indeed, the maturity model provides a mean to evaluate each axis locally (each axis can evolve at different levels) but the impact on other axis must be considered and the mechanisms to know and to evaluate this impact must be also developed in order to develop the right and the better strategy of progression.

$$M_G = f'(Governance, Logitics, Care) \quad (2)$$

With: M_G: the Global maturity.

Governance, Logistics and Care: the Local Maturity.

Furthermore, the evolution of field hospital from each level to another is driven with some recommendations to define. In this case, it is necessary to define rules to formalize the transition from one maturity level to another. Most of maturity models in the literature, state that recommendations, practices and requirements proposed in each axis of interest at each maturity level must reach their goals before moving to the next level (CMMI, 2002). These recommendations have to be clear and exploitable to enable a simple evolution and to make easier the achievement of changes.

5. VALIDATION OF FIELD HOSPITAL MATURITY MODEL

In order to get a relevant model and to provide proper recommendations, the proposed model is validated and tested with the support of the stakeholders (ESCRIM Team from SDIS 30), in the case of the HOPICAMP Project. Indeed, at each step of the development, the maturity model *i.e.,* the axes of interest, the maturity levels and further the recommendations are improved and validated. This validation done through iterations with the stakeholders to validate (or not) each development or evolution of the model.

In this way, the first validation was related to the 3 axes of interest. The SDIS 30 considers that 3 axes facilitates the readiness of the maturity model and are fully related to the field hospital deployment. The second validation was related to the maturity levels. On this point, the issue was related to the number of level: why to propose five levels while the care aspect has three levels regarding the WHO model (Norton *et al.,* 2003)? In fact, the WHO model is widely used to evaluate a field hospital for all care aspects with three levels (*outpatient emergency, inpatient surgical emergency and inpatient referral)* that can be considered as maturity levels. The general rule choosing the number of levels is that "*the optimum level of maturity is recognized as being the level that delivers the organization's strategic objectives most effectively and efficiently which does not necessarily mean level five*" (Jansson, 2011). As a consequence, five levels seem the most appropriate. This number is based on the fact that (1) a too small number of levels does not allow a precise evaluation (*e.g.* binary), (2) a too large number of levels bring details not necessarily useful for the users, (3) the evolution throughout levels has to be progressive to allow an effective progression (*e.g.* cost, human and materials means are engaged to evolve) and more marginal and (4), a common number of levels can allow to align different maturity models if it is useful (Daclin *et al.,* 2016).

6. CONCLUSION

To face up emergency situations and support impacted areas, some countries and non-governmental organizations set up temporary medical solutions such as the field hospitals. They are deployed in a few days and provide the standard hospital services on-site until local medical facilities are able to work properly. In this way, the assessment of the organization regarding to the deployment allowing to know their strengths and weaknesses and further to progress to be better is a key factor. To this purpose, the method presented is based on the use of a maturity model. The proposed maturity model is based on the study of (1) the structure and the organisation of field hospitals, (2) documents offering guidelines and recommendations for field hospitals, (3) other related models and maturity models and (4) standards and norms from countries in disaster as well as helping countries. The result is

a structure of a maturity model providing the major axes to consider and to develop in a field hospital as well as different maturity levels and their definition allowing organizations to be positioned regarding to the axes of development. Currently, the maturity model is continuously refined, populated and validated with the support of the ESCRIM Team. In this way, a first validation was occurred regarding the maturity levels and the axes of interest.

Next research works is the definition of the recommendations allowing users to evolve throughout the maturity levels according to the result of the maturity assessment, their own objectives and capabilities. . Other future works are related to the proposition of metrics to assess of field hospital.

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