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# Enhancing Collaborative Healthcare Synergy

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**Abstract.** Worldwide, the constant ageing of the population brings significant challenges to the traditional style of health care systems. Rapidly spreading pandemics triggered by new disease strains, increased population mobility and displacements fuelled by conflict and climate change add another dimension to the health care predicament. In this context, proper cooperation and interoperability of the participants in the healthcare effort becomes paramount. Collaboration is an essential factor but also a major challenge, as typically healthcare institutions are hierarchical and heterogeneous, owing to various administrative, geographical and historical reasons. As the pressure on healthcare availability, quality and cost is constantly increasing, governments can no longer rely on traditional models for managing population wellbeing. Innovative holistic and integrated models and procedures taking into account all essential aspects, elements, participants and their life cycle are necessary if these challenges are to be successfully met. Based on previous research and applications, this paper argues that such necessary artefacts can be built using a life cycle-based whole-system paradigm enabled by advances in Collaborative Networks and Enterprise Architecture. This approach aims to provide a sound platform for efficient response delivered by agile and synergic teams to short and long-term challenges to population health and well-being.

**Keywords:** Health Care, Collaborative Networks, Enterprise Architecture

## 1 Introduction

Worldwide, healthcare situation is radically changing. Earth's population is constantly ageing as people live longer [1]; while reflecting mankind progress and providing some benefits [2], this state of affairs also brings significant challenges to the human society - especially in social security and healthcare [3]. Thus, the pressure on healthcare services availability and cost is increasing worldwide, with governments no longer being able to manage population health using 'legacy' models. Another major healthcare concern is the growing risk of pandemics, owing to drug-resistant diseases and increased population mobility facilitated by modern means of transportation and fuelled by regional conflicts, economic crises and climate change.

Due to a number of regional, historical, organisational and political reasons, there are significant challenges in managing both internal and external collaboration and interoperation of the typically heterogeneous set of participants involved in the healthcare endeavour. This constitutes a critical issue in handling epidemic and pandemic events that require prompt response and typically claim resources and

capabilities beyond those of any particular individual healthcare organisation. New innovative and especially integrated models, methods and tools are required in order to enable proper inter-professional and inter-organisational cooperation so as to cope with the new issues brought by the changing healthcare environment.

Previous research [4, 5] has investigated the use of Collaborative Networks (CN) [6] and Enterprise Architecture (EA) [7] concepts and methodologies in tackling generic disaster management efforts. This paper aims to build on the previous results by focusing the application of CN and EA artefacts to the healthcare area. It is hypothesised that this approach will allow addressing the above-mentioned issues in a life cycle-based, holistic and integrated manner; this should enable a prompt and efficient response by agile and synergic teams to both acute and long-term challenges to population health and well-being.

## 2 Challenges in Healthcare Management Collaboration

Healthcare has made significant advances in the last century, such as the development and wide use of vaccines, eradication of serious diseases and large reductions in communicable disease epidemics and chronic diseases [1, 8].

While solving some very important problems, some of these advances have unfortunately also contributed to a new set of challenges faced by the public and private healthcare infrastructure and organisations. Thus, nowadays we are confronted with population growth and ageing triggered by increased longevity and health hazards owing to causes such as climate change [9] and new strains of diseases [10].

While healthcare as a system has become somewhat more organised, it has also become more expensive, complex and difficult to manage. New technologies hold the promise of remote medical assistance and automated care at home; however, the main problems remain human-related, namely overcoming the organisational and cultural barriers to collaboration and synergy of the healthcare professionals and organisations. Although collaborative healthcare is argued for and encouraged in various medical and other emergency response reports, conferences and journals (e.g. [11-17]), unfortunately the extent of actual collaboration is still limited.

The relevant literature also argues that effective collaborative healthcare could be enhanced by modelling and participatory design [18] aimed at integrating scientific but also administrative and political aspects into a whole-system approach [12, 19, 20]. For example, the long term healthcare issues may be alleviated by the vision and strategic research espoused by Matos et al. [21] and the BRAID project [22] who advocate the necessity for integrated assistive services and infrastructure supporting collaborative healthcare ecosystems [23] as a component of a healthy living and ageing support paradigm [17]. Psychological disaster effects such as uncertainty, anguish, confusion, panic etc are significantly augmented in pandemic-type situations and must be properly dealt with by building appropriate and *specific* preparedness of the organisations involved [19, 24], with ethics playing a prominent role [25, 26].

Owing to the urgency involved, often there is a tendency of the higher ranking and more powerful organisation(s) to override or exclude some participants, adopting a 'central command' approach in preference to a cooperative one [27]. This is not

desirable as successful disaster management (including healthcare crises) relies on a wide range of community economic, social-psychological, and political resources. This cooperation brings communities together, gives them a sense of usefulness (ibid.) and thus also alleviates the negative psychological effects.

Collaboration between participants in the healthcare effort does not automatically occur. It must be “constructed, learned, and once established, protected” [28]. Like most human-related processes, collaboration can neither be successfully forced on the participants nor achieved in a short time. The divergent perceptions and expectations of the parties involved [29], owing to a traditionally strong hierarchy and marked difference in status between partners [30], can be best dealt with by the higher ranking participants. They can promote collaboration and trust by employing a participatory and inclusive approach [31] which will also build a beneficial sense of security [32].

To conclude, efficient healthcare collaboration requires that organisational cultures, processes and resources of the participants acquire suitable preparedness [11]. This requires access to a plethora of interdisciplinary information and knowledge not always obvious or easily accessible to planners and disaster managers.

### **3 A Combined Collaborative Network / Enterprise Architecture Approach for Healthcare**

The concept of networks in disaster management and recovery as an alternative to a centralised command and control approach has been advocated, studied and applied to some extent for a number of years with mixed results (e.g. [27, 33-35]). While providing valuable data, such attempts appear to have two main shortcomings. Firstly, they propose previously untested models focusing on a specific aspect in isolation, rather than employing a proven set of integrated models in a whole-system approach. Secondly, the life cycle aspect of the participant organisations, networks and other relevant entities (including the disaster event/s) appears to be less addressed. As all participating entities are evolving, it is essential that the interactions required for collaboration and interoperation be considered in an integrated life cycle context.

In attempting to address these issues, it has been observed that the healthcare challenges identified in the critical literature review describe a situation similar to that of commercial enterprises who, owing to a global business environment, find themselves compelled to tackle projects requiring resources beyond their own staff, knowledge and time capabilities. Their usual reaction to this problem is to set up or join so-called Collaborative Networks (CNs) that act as breeding environments for Virtual Organisations (VOs) who are promptly created in order to bid for and (if successful) complete projects requiring combined resources and know-how. The view of CNs as social systems composed of commitments, who absorb uncertainty and reduce complexity [36] also supports their use towards large inter-disciplinary tasks.

Integrated modelling in a life cycle context can be further facilitated by artefacts provided by Enterprise Architecture (EA) research and practice. Thus, EA as a change management paradigm that bridges management and engineering best-practice [7] is capable of providing a framework integrating all necessary aspects in a life cycle-based set of models ensuring the consistency and sustainability of complex projects.

Furthermore, the fact that large scale medical emergencies such as pandemics are particular types of disaster events justifies and facilitates the use of previous research results in applying CN concepts in disaster management, supplemented with an EA perspective providing the essential integration and life cycle perspectives [4, 5]. Fig. 1 presents the main issues identified in collaborative healthcare and the potential solution and benefits brought by a CN approach enhanced with EA concepts.

Healthcare Issue	Applicability	Help from EA and CN
Divergent perceptions of the participants' roles	Long / Short Term	Clear, agreed roles for network and task force participants
Lack of trust between participants	Long / Short Term	Trust building in time, within the network
Poor life cycle management of task forces / collaborative healthcare	Long / Short Term	Intrinsic life cycle context to the creation and operation of network and task forces
Difficulties setting up and operating Collaborative Healthcare (e.g. unclear rules, disagreement on the present and future situations)	Long / Short Term	Participatory design, inclusive approach by lead network partner. Agreed upon models of Networks as Collaborative Healthcare Ecosystems.
Focus on a limited set of interoperability aspects	Long / Short Term	A whole system approach integrating all relevant aspects
Information sharing and cooperation impeded by traditional hierarchy	Long / Short Term	Information and process interoperability achieved at network level and carried on in task forces created
Tendency to overrule rather than cooperate in task forces	Short Term	Cooperation previously agreed upon and built in the task forces created by the network
Lack of preparedness to participate in a task force on short notice	Short Term	Participant preparedness built in advance within the network, ready for fast taskforce / VO creation
Difficult discovery and assessment of suitable participants for an effective and agile task force	Short Term	Task forces created promptly using pre-qualified network partners implementing agreed upon processes. Interoperation and agility built in.

**Fig. 1** Main collaborative healthcare barriers and solutions offered by EA and CN

Adopting a CN approach for health disaster management provides benefits going beyond mere technical and syntactic-type interoperability. Thus, the participants in a 'healthcare management' CN (HMCN) have the time and suitable environment to overcome hierarchical, organisational and typically troublesome cultural interoperability [37] barriers and achieve suitable *preparedness*. This is essential in the prompt and successful setup of 'health management task forces' (HMTF) for disasters but also for the creation and operation of continuing VOs (e.g. as described in [38]) for long term collaborative healthcare challenges such as population ageing.

The CNs and VOs set up for the healthcare domain would have specific features. For example, the competitive motivations of commercial CN participants who guide their decisions to create / join / remain / leave the network would transform into the stringent need to cope with increasingly complex health challenges and healthcare systems. The use of reference models, customary in commercial CNs, is feasible here but may be limited due to the diversity in scale and type of healthcare incidents [39].

Importantly, for the health management CN to function, the typical CN 'lead' partner/s (here, government emergency management / healthcare agencies) need to take a participatory and inclusive approach. Thus, scientific, faith and community representatives and all relevant non-governmental and volunteer organisations should also be included in the setup and operation of the HMCN, in addition to the typical participants such as hospitals, allied healthcare [40], fire and rescue services, etc.

### 4 Life Cycle Integration Modelling for Collaborative Healthcare

Successful integration modelling of the CN approach must be done collaboratively with all the network participants [20]. The proposed method and artefacts support this audience variety by using suggestive graphical models and complexity management.

While several EA frameworks would have been suitable, we have selected the modelling framework (MF) provided by GERAM (Generalised Enterprise Reference Architecture and Methodology), described in ISO 15704:2005 [41]. This MF provides a large set of aspects, importantly including life cycle, management, organisation, human and decision. In this paper we will use a subset of the GERA MF containing the life cycle and the management / services viewpoints (see Fig. 2, left). Fig. 2 right shows a sample use of the GERA MF life cycle viewpoint to define and map life cycle phases of a health incident on typical health disaster management activities [42].

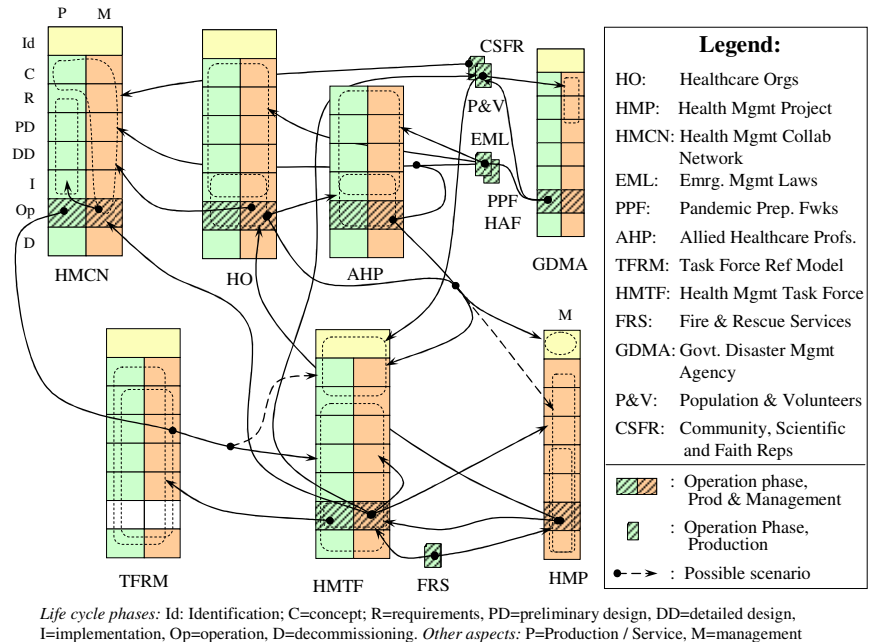
Prod. Mgmt		Health Incident Life Cycle Phase (GERA MF)	Health Disaster Management Phase	Comment
Id	Yellow	Identification	Prevention	Identification of the Health Hazard
C	Light Blue	Concept	Prevention	Response Required? Why / why not?
R	Light Blue	Requirements	Preparation	Response Requirements
PD	Light Blue	Preliminary Design	Preparation	Response Solution (Principles, Policies)
DD	Light Blue	Detailed Design	Preparation	Detailed Response Solution; Prepare Partners for fast Task Force Implementation
I	Light Blue	Implementation	Response	Create Health Disaster Management Task Force
Op	Diagonal Stripes	Operation	Response	Deploy, Respond
D	Light Blue	Decommissioning	Recovery	Decommission the Disaster Management Task Force or reconfigure it for Recovery

Fig. 2 Mapping a health incident on disaster management using GERA MF phases

Fig. 3 shows a sample model of HMCN and HMTF creation and operation that integrates the life cycle and management aspects. Note that a complete modelling exercise (not possible here due to space limitations) should contain diagrams covering all the *required* aspects. The use of viewpoint combinations based on the same MF will facilitate producing and maintaining a coherent set of models.

The arrows in Fig. 3 show influences and contributions among the stakeholders previously identified to be of interest to the long and short term healthcare concerns. Thus, healthcare organisations HO (e.g. hospitals), allied health professionals (AHP) and scientific, faith and other communities representatives all contribute to the design and operation of a HMCN in its various life cycle phases. These contributions may also extend directly to the design and operation of the HMTFs created by the HMCN, and even to the health management projects (HMPs) created by the HMTF. Influences and contributions also come from ‘non-physical’ artefacts such as emergency management laws (EML), pandemic preparedness (PPF), or healthcare assessment frameworks (HAF)[17]. Feedback from population, organisations and community representatives is used to improve Government agencies (GDMA) and the HMTFs.

The arrow from HMTF’s Management side of the Operation life cycle phase to some of its upper phases represents a very important ‘self partial redesign’ capability, showing a need for the HMTF to be *agile* and adapt in real time in the face of rapidly changing conditions on the ground that are typical of some disaster events. Any major HMTF reconfiguration will however need to involve the HMCN participants.



**Fig. 3** Possible life cycle model of collaborative health system setup and operation

Note that a high-level model such as shown in Fig. 3 does not aim to provide all the details necessary for actual implementation upfront. Rather, its main purpose is to facilitate stakeholder consensus on the problems of the present state and support the selection of the optimal future state. Such models can provide checklists of the entities that need to be considered in the collaborative healthcare endeavour and spell out the interactions between them, in the context of their life cycles. They can also represent organisational autonomy and agility and thus help reveal hidden problems. Once consensus has been achieved, the models can be decomposed and evolved into detailed design and implementation blueprints.

### 5 Conclusions and Further Work

Collaboration and interoperation are paramount in healthcare in order to meet major contemporary challenges. Politics, hierarchy, lack of trust, dissimilar organisational cultures and limited or missing integration and life cycle-based perspective of the participants' roles are decisive factors that can be addressed by prior preparation in a suitable environment. This paper has argued that the healthcare endeavour could significantly benefit from adopting a CN paradigm applied from an EA perspective and has attempted to exemplify a high-level integration modelling example involving CN and EA artefacts. The paper makes a theoretical contribution by emphasizing the connection between CN, EA and healthcare research and a practical contribution by

providing an example of how CN concepts can be employed from an EA perspective in order to model a collaborative healthcare solution to health and well-being challenges. The proposed approach will be further developed and applied to several healthcare management case studies in order to verify, validate and refine it.

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