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Increasing Autonomy In Health Care Management With Teal Organizations

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Abstract—**The authors present an improved solution of management in Healthcare Information Systems (HIS), considered more flexible and effective than the traditional hierarchical management. The proposed solution recommends to use teal organization with self-organized management in order to offer increased autonomy in decision-making for HISs involved in medical crisis control.**

Keywords—***self-organization, self-management, teal organizations, autonomy, decision- making***

I. Introduction

Despite the global expansion of the globalization process in all areas - professional, academic and political - manifested by increasing the influence of centralized control, Information Technology and Communications, which provides logistical support for any management structure, offers us two approaches: on the one hand - decision and control systems based on centralized information sources, brought to the extreme by Cloud Computing technology, on the other hand distributed control structures based on peripheral networks (Edge Computing) to which autonomy in decisions becomes essential. The second approach is rapidly gaining ground, as it is the only one that avoids the blockage that occurs due to the connection of a huge number of devices to the WEB. Autonomy of an entity translates into a series of actions that take place autonomously, i.e. by it*self* - *self*-organization and *self*-management are essential in this regard. It is interesting that the return to decentralization occurs not only technically, but also socially. The changes in the business environment and the increasing complexity of the work cause the increase of the interest for the self-organized teams, which decide the way in which they carry out their work and at the same time they adapt to the frequent changes.

We are now, when entire world is fighting a viral pandemic, in the situation where the most important medical solution was "Stay at home". But this decision announced an imminent economic crisis, for which the only solution was work from home. It seems natural to ask ourselves whether the increase in autonomy in the management of health services achieved through self-organization is beneficial.

There are two ways to achieve self-management: i) using specific rules and tools to guide patients to a right behavior; ii) establishing a collaboration relationship of agreement type between doctor and patients for choosing the path to follow [1]. The two objectives are not antagonistic and can be achieved simultaneously, while in both situations' management autonomy is done by decision-making autonomy.

The present paper aims to provide evidence to highlight the advantages of both approaches, or more precisely to ensure a change in patients' behavior in a collaborative agreement to produce lasting effects. In this sense, it is suggested that a relatively new social technology - teal organization - can bring consistent and advantageous solutions.

II. Decision-making in centralized vs distributed systems

In complex systems with centralized management, the decisional coordination is performed in principle through a top-down strategy. In systems of this type the center is fully informed on the parameters of the objective function of the components (subsystems) and based on a set of admissible values of commands that can be issued, creates an operational environment for an efficient functioning of the elements (performing actors) to which it delegates the competences in decision-making for achieving the optimal target parameters.

The alternative to this way of structuring the decision-making process is a relatively new concept of organization called holacracy [2]. Holacracy was introduced as a system of organizational governance, where decision-making is distributed in a holarchy of self-organizing teams, composed of holons. The structural unit (block) of holacracy is the team. Even though holarchies were imposed on models specific to industrial systems (particularly in manufacturing), holacracy as a form of management was conceived and developed strongly in the area of the business environment. Well-known and intensively studied complex architectures, such as Mutual Assistance Communities (MAC) or Service-oriented Community (SoC) [3] can in turn be coordinated on the principles of holacracy.

Often, in structures based on social resources, the term "holacracy" is replaced by "sociocracy". A representative support for sociocracy is the Fractal Social Organization (FSO)

[4]. Actually, FSO is a fractal structure whose building block (node) is a SoC. Nodes in FSO hierarchies are in fact similar to sociocratic circles, having three main responsibilities: to direct, operate and measure its own processes.

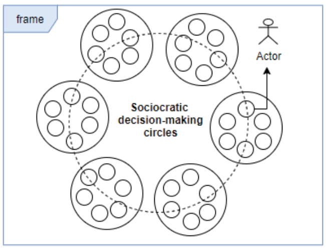

Fig.1. The frame of holacracy in decision-making systems (owns presentation based on [2])

The frame of holacracy, presented in fig.1, has a predefined set of rules and processes that simulate an operating system that helps the self-organization and self-management of human agents. However, by stimulating self-organization, holacracy opens the way for an autonomous decision-making (ADM) [5]. With ADM any agent from distributed and localized systems can make decisions based on its own point of view for any goal it want to achieve and also for the other collaborative agents. In recent years, there has been discussion about a new organizational concept that ensures self-management with a higher degree of autonomy than holacracy - this is Teal Organization (TO).

III. Teal organization and self-management

The TO concept was introduced in Laloux's book „Reinventing Organisations" [6] as a organizational structure designed "to enable individuals to self-organize and self-manage to achieve determined responsibility" in a "bottom to up" organization flow. The basic building blocks of this model are self-managing teams classified in 5 categories according specific operational features and labelled with different colours: red, amber, orange, green and teal. The „spectral" order corresponds to the degree of autonomy in decision-making, the highest being teal. „Teal organization" is defined as „ self-management for evolutionary purpose" [7].

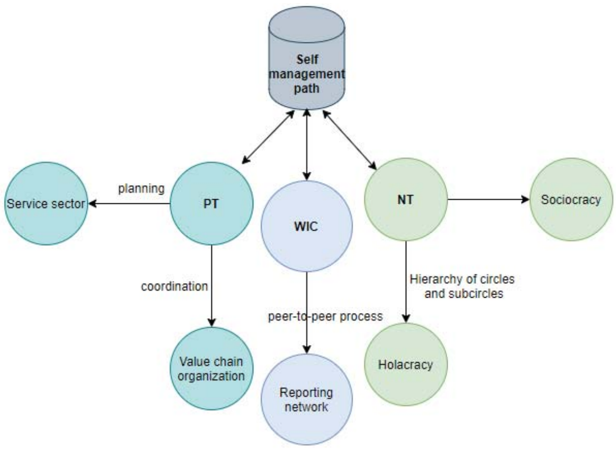

Fig.2. Paths of self-management in teal organizations

There are 3 paths of self-management in teal organizations (see Fig. 2): Parallel Teams (PT), Web of Individual Contracting (WIC), and Nested Teams (NT)

As in holacracy and sociocracy, the structure is organized in „circles", but the difference is done by the self- management process and the decision-making mechanism. In table 1 are presented the main organizational factors which sustain the self-organized management, for the most authorized representatives of the self-organized structures that are based on circles [8].

TABLE I. The organizational factors in self-organized teams

	Teal organization	**Holacracy**	**Sociocracy**
Management	Supports team initiatives, ensured freedom and flexibility	The management process is based on circles and roles	The flow of information is ensured by circle managers
Decision-making	Not based on command-and-control, nor on the hierarchical power	Occurs at each level of the hierarchy	Based on consensus
Process	Divided into individual teams;	Related to duties within to a given circle;	All the members of team have responsibilities
Structure	Parallel circles, networks	Organizational circles, roles	A circle way has a manager

IV. Teal organizations in HIS.

It has long been known that self-organization is appropriate for primary medicine [9]. We also mentioned that TO has similar structure as FSO. In a previous paper, we have shown that FSOs can act as blocks in fractal organized HIS [4]. FSO has a strong emphasis on self-organization, offering a common goal for all members of the organization. Other characteristics of FSO similar to TO are self-management, individual purpose, flexibility and decision-making. Consequently, we can extend the reasoning and state that TOs can be used successfully in HIS.

Primary care and general practice can be characterized as an open self-organizing socio-technical system. To emphasize the attributes of TOs in HIS management, we discuss in the following about some management issues in a medical crisis. In case of a medical crisis situation, such as the pandemic caused by Covid 19, serious management problems arose from the phase of detecting cases of infection and the decision to hospitalize cases with clear symptoms in hospitals. We identified three such issues that justify the appeal to teal organization, especially regarding the autonomy in decisions:

1. The essential role of family doctors (we will use the name of General Physician (GP)), to whom all patients were referred before going to the hospital and who thus became the primary factor of triage. Not only was their role in avoiding hospital overcrowding decisive, but the peer-to-peer relationship established between physician and patients broke the classic hierarchical chain, establishing a local decision loop that is part of what we defined as Web of Individual Contracting (WIC).

2. Fluctuations in the hospitalization capacity of hospital units, determined in turn by three major causes: i) classification of these units in the Covid or non-Covid category; ii) the limited number of beds properly equipped in the Intensive Care Units; iii) changes in the medical staff, especially reductions due to their infection and isolation. The management of such situations could be improved if we used what we have defined in the description of teal organization as Parallel Teams (PT), because by using such a structure it is possible to maintain small operational groups that act independently and in parallel.

3. The introduction of the quarantine regime in a city with a large population, which contains numerous hospital units, analysis laboratories and research institutions, public or private, which are thus put in a position to provide medical services in a spatially delimited area and in the shortest possible time to process all emergencies. The situation corresponds to the teal organization management scheme called Nested Teams (NT). NT corresponds to the concept of circular holarchy in which the units are circles that in turn are divided into sub-circles, each with well-defined roles.

V. Self-organized healthcare services based on Autonomy Oriented Computing

A. Management model of medical NT structures

The management model we propose aims at optimizing the distribution of patients in a complex system of hospital units organized in a circular structure of NT type, in the conditions of a pandemic that imposes spatio-temporal restrictions, based on principles of self-organization and self-management. For this purpose, the self-similarities (self-organized regularities) of the arrivals and the waiting time derived from the historical data in the records of each interconnected medical unit will be analyzed. Additionally, input data will be added that refers to [10]: i) Scope - specify hierarchical variables, processes, and levels that are relevant to self-organized regularities; ii) Interactions - specify relationships between the factors and the impact variables, in order to identifying local feedback loops; iii) Heterogeneity - specify differences in the profile of the staff, the socio-economic environment and the availability of the service.

The model is developed on the base of the Autonomy Oriented Computing (AOC) concept [11], introduced as a suitable self-organization solution for ensuring interactivity between various entities with autonomous behaviors. The following preparatory steps are required to model an AOC system: i) Identifying the participants (entities), the main impact factors and the already functional feedback loops at local level; ii) Identifying the characteristics of the environment and defining it; iii) Defining the autonomous behaviors of different entities and also the rules of behavior.

B. Problem statement and solving.

Assumptions.

1. Sending patients to the hospital is based on an agreement with the General Physician (GP), which leads to a patient-GP mutual decision (agreement), on the basis of environmental information obtained from environment *E*.

2. GP has a predefined list of rounded patients, specified in *E*. This list is adapted periodically (at least once a day) depending on the probability of generating the flow of patients $M=\{m_i\}$ for each medical unit c_i in the interval (time step) of 1 day. This probability is predicted based on historical data from previous days.

3. The medical units in the city are interconnected in a bipartite network *CH (C, H, D)*, with $C(N)=\{c_i\}$ where c_i, $i=1,\dots,N$ are non-Covid units, $H(M)=\{h_j\}$ where $h_j, j=1,\dots,M$ are Covid hospitals. We assume $H \cap C = \emptyset$.

4. $D=\{d_{ij}\}$ $(i \in [1,N], j \in [1,M])$ is the set of edges d_{ij} having each a weight corresponding to the driving time from a c_i unit to a h_i unit. *D* is a characteristic component of the environment *E*, in our case representing a distance information and also an impact factor, which especially influences the waiting time. However, there are other features of *E* that can be taken into account, such as the endowment with special investigation or therapy equipment or the diversity of medical services offered.

5. The wait time $W=\{w_i(t)\}$ records information for each hospital h_i starting with an initial time t_0; W is expressed in units having a predefined number (positive integer) of 1-day time steps. *W* is also a (temporal) feature of environment *E*.

6. Another impact factor characteristic of the *E* environment is the probability of generating the flow of patients $M=\{m_i\}$, for each medical unit but in the interval (time step) of 1 day. This probability is predicted based on historical data from previous days.

7. The emergency character is established by the general practitioner (GP entity), who can generate flow information $A_k(t)$ for patient *k* out of a number of *K* patients $(k \in K)$ who need emergency care.

8. The patient entity P_{ID} is labeled with a unique ID that is a constant for each patient. The patients are those who decide which medical unit he will go to after receiving the recommendation from the GP. There is a possibility that they will go directly to a Covid hospital unit, but only if they have received confirmation of the virus infection through a preliminary test. In all other situations they will go to a non-Covid unit c_i where they will be tested and then directed accordingly of the test result. The choice of the unit is made according to preferential criteria (reputation of the unit, of the medical staff, distance from home, information regarding the waiting time). In our study the only selection criterion was the shortest waiting time. According to the severity of illness (don't forget that the patients may have more co-morbidities) the patients chooses for the type of service (emergency or non-emergency).

9. The flow of patients has as end point the hospital entity *H*. Based on the GP-patient agreement specifying the destination hospital and the degree of urgency, patients arriving at the destination are positioned in queues. Each queue has a certain service rate that depends on both the hospital's human resources and the management strategy used. This rate can be adjusted up or down depending on how the number of people in the queue

changes, according to known rules formulated in queue theory [12].

C. Simulation program

The simulation program analyses the hospitalization waiting time. At each time step, a medical unit c_i provides a number of patient entities and communicates that information to GPs. Each of the patient entity selects a destination hospital together with the GP based on behavioral rules. When reaching their destination, the patients are placed in the queue, where they will be served after a service time established based on the mean rate l_j. Information about the waiting time within a time round must also be communicated as a characteristic of the environment E. Then using the analysis of self-similarities in past time series, the following time thresholds can be predicted:

T_r – The time round, indicating the period of time after which the wait time in a hospital is resumed
T_s - The time unit, indicating the number of time steps after which the service rates $l(t)$ are adjusted
T_e – The moment when the hospital releases the wait time information to E
T_t - The total simulation time

The simulation procedure for access in a Covid hospital has the following steps:
Step 1. Begin. Initialize parameters, set $t=1$.
Step 2. Each GP updates their patients flow information $A_k(t)$ based on predefined lists communicated by c_i medical units accordingly to their patient-generation probability m_i.
Step 3. Each of the patients P_{ID} selects a medical unit based on the behavioral rules and the information in E. If P_{ID} has already a confirmation of infection, go to step 5. If not, go to step 4.
Step 4. The patients access a c_i unit where are examined and tested for virus contamination. If the test is positive, go to step 5. If not, the patients are hospitalized in the c_i unit. In our model, a c_i unit disposes only of non-Covid sections. On the other hand, being sorting stations, c_is have access to information that allows the selection of a Covid hospital according to different criteria. Here, however, the destination is to the h_j hospital initially chosen by patient.
Step 5. Each hospital h_j proceeds to following stages: i) queues the new coming patients; ii) serves patients based on a M/M/1 queueing model; iii) updates the waiting queue and the information about wait times.
Step 6. If $t=T_s$ go to step 7. If not go to step 8.
Step 7. Each h_j adjusts the service rates, then go to step 8.
Step 8. If $t=T_e$ go to step 9. If not go to step 10.
Step 9. Each h_j releases the wait time information to E, then go to step 10.
Step 10. If $t=T_t$ go to step 11. If not, increment t with one unit ($t=t+1$) and go to step 5.
Step 11. End.

VI. Conclusions

The aim of the paper was to show that important problems of organization in the health system in a special situation of major crisis can be solved efficiently using one of the structures of Teal Organization type, namely Nested Teams. In order to demonstrate the advantages given by the use of NT, a relatively simple program of orientation and triage of patients suspected of viral infection was run by simulation, with the ultimate goal of minimizing the waiting time. Unfortunately, at the time of writing we could not benefit from real data. In the meantime, a huge volume of statistical data has been accumulated, including the vulnerabilities of hospitalization solutions, so we are sure that the ideas that have been suggested by us are important for further research. The experiments focused only on the aspects of self-management at the local level, without any intervention of a central control mechanism, but its implementation requires on the one hand the use of dedicated prediction programs based on the history of data based on the self-similar fractal character of regular patterns and on the other hand the taking into account of several impact factors and operational constraints. This will be indeed the objective of future research, which aims to highlight the advantages of self-organized "teal" structures in the realm of FSOs involved in HIS.

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