# Bogota's Emergency Care System*

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***Abstract*—This article will show the different observations obtained from the systematic analysis of the emergency care system, which is a complex network designed to manage urgent medical situations through the coordination of personnel, technology, and facilities to deliver immediate care. To enhance its efficiency, I propose an integrated solution that ensures seamless communication between the system's elements, such as emergency call centers, transport, and medical teams, while addressing potential challenges like traffic jams and prank calls. As a result, this approach leads to more effective emergency response times, improved coordination, and a reduced risk of system collapse due to external or internal disruptions.**

***Index Terms*—Emergency care system, system coordination, stochastic and deterministic systems, chaos theory, synergy, entropy, homeostasis**

## I. Introduction

The emergency system is defined by the African Journal of Emergency Medicine as *"The delivery of health services for conditions that require rapid intervention to avert death or disability, or for which delays of hours can worsen prognosis or render care less effective"*

One of the distinguishing features of emergency care is the diagnosis, treatment and initial stabilization of a wide range of undifferentiated patients with acute illnesses.

Patients may present with any complication, from acute medical conditions to obstetrical or surgical needs.

A good emergency system serves three main functions:

1) It serves as the main entry point into the healthcare system for all patients with symptomatic conditions.
2) Allows for the early treatment of acute crises of chronic diseases
3) Provides an essential safety net for patients with no other links to care

Furthermore, it is important to bear in mind that the service offered by this system also covers care from before the patient arrives at a hospital center, for example, care provided by pre-hospital providers at the place where the accident occurred, until the transition to care at the relevant unit. This concept is reflected in the emergency care systems developed by the World Health Organization (WHO), which defines the key elements and processes of each component of emergency care system, including care at the scene, care during transport and emergency care at the centers.

In Colombia, the emergency care system or SEM (Sistema de Emergencias Medicas) is also governed by the Ministry of Health and Social Protection, which states in Resolution 926 of 2017 that the emergency care system is a general integrated model that seeks the articulation of the different actors of the General System Of Social Security in Health, to ensure timely response to victims of disease, traffic accidents, trauma or cardiorespiratory arrest requiring emergency medical care.

The emergency system has different process in its operation. First, the telephone operators receive the call and determinate if the person needs an ambulance, then, the call is transferred to the CRUE, the Emergency and Urgent Care Centre, the entity in charge of coordinate the attention and resolution of medical emergencies in Colombia. This entity, classify the emergency and send the most close ambulance, according to the necessity, because the person could need a special medicine or treatment. Next, the ambulance will pick up the person, and depending on the emergency, in the ambulance you will find a professional according to the seriousness of the situation.

Once the ambulance arrives at the scene of the emergency, the medical team on board,assesses the patient's condition. Then, they perform triage to determine the severity of the situation and prioritize care. During transport, basic medical interventions can be initiated, such as administering oxygen, stabilizing fractures or initiating CPR if its necessary.

When the patients arrives to the care center, him or her is greeted by the medical staff of the hospital or clinic. Further evaluation is performed to confirm the diagnosis and determine appropriated treatment. At this point, all relevant information about the patient and the care provided during transport is recorded.

Finally, after the final diagnosis is given, the necessary treatment is performed to save the patient's life. Depending on the patient's condition, he/she will be treated in different parts of the hospital.

Understanding how this entire process works is absolutely necessary in order to subsequently perform a systemic analysis of the emergency care system. Only in this way will it be possible to understand which elements are part of the system and how they relate to each other to finally form a whole and function in the most efficient and effective way possible.

## II. Methods and resources

In order to perform the corresponding systemic analysis of the emergency system, a Top-Down methodology was implemented.

To further the use of the Top-Down methodology in the systemic analysis of the emergency care system, we set out to dissect the system starting from its most general functions and progressively moving down to the finer components. This method provided a structured approach to comprehensively understand how each element contributes to the overall effectiveness and coordination of the system.

Initially, the system was examined at its highest level to identify its main objective: to ensure timely and effective medical responses to emergencies. By understanding the overall objective, it was possible to map the major subsystems that make this functions possible, such as patient communication, transportation logistics, medical staff coordination, and resource management. Each of these subsystems was then broken down to reveal the intricate relations between their parts.

Subsequently, the emergency call center was analyzed as the entry point of the system. By analyzing its operation, key data was identified, such as the type of illness and patient location. This data flows into various decision-making processes that dispatch ambulances, determine the necessary medical personnel, that can vary between paramedics, emergency medical technicians or doctors, and mobilize medical teams.

Finally, after identifying all the elements of the system, we analyzed which were the underlying elements that emerged or were connected with some of these elements. These specific elements are those that although they are not directly related to the operation of the system, they turn out to be a fundamental part of it, allowing it to work in the best way.

In addition to analyzing the elements of the system, it was also important to analyze the environment in which the system was deployed and what were the emerging behaviors that could arise randomly, based on the Top-Down methodology.

In one hand, the environment plays a critical role as it directly influences the system's performance. Factors such as geographic conditions, traffic, population density, and local infrastructure can significantly affect the response times and effectiveness of the emergency care system.

On the other hand, emergent behaviours may not be directly predictable through the analysis of individual system components but become evident when considering the system as a whole. The Top-Down methodology allowed for the identification of sch behaviors by starting from the macro-level overview and gradually delving deeper into subsystems to understand how these phenomena manifest.

## III. RESULTS

According to the elements and relations founded in the system analysis, the emergency system has some characteristic in its functioning.

### A. Effects

The domino effect is present when you cut the means of transport, because, the life and the integrity of the patient, it depends on how quickly you get to the hospital and if it fail, next processes will fail.

In the butterfly effect it was analyzed that the information provided by the patient is a important factor, because omit information could generate complications then, for the ambulance type or other things.

Also, the snowball effect occur when the system has fake data, considering that each part of the system are waiting for act, but if you have a prank call, all the elements will start to perform its function, the line will be occupied and the system will lose time with this call.

### B. Properties

The system analysis provide information that could be categorise according to the definition of each property to have a better description of the system.

- Entropy: The medical area has too many aleatory things, because you do not know how the patient body will react, and taking into account the other elements founded, each one has a aleatory factors like the traffic Jam, illnesses, and different things, for this reason, it is determined that the system has a lot of entropy.
- Homeostasis: The system has different emerging behaviors and the system lose balance, however, it has some protocols to counteract the emerging behaviors, causing that the system get balance for its own way, giving homeostasis to the system.
- Synergy: It was found that the system has high entropy, because all the system have to work together to guarantee the health of people. As well, the elements have a good coordination among them, and make that the system efficient.
- Stochastic or deterministic: the elements have interactions which has an aleatory component, because the emerging behaviors make that they system can not be predicted with certain, taking into account emerging behaviors like the traffic jam, the condition of the patient, prank calls, among others, therefore, for the unpredictability in the med area and the other things mentioned, the emergency system is a stochastic system.

### C. Chaos theory

The sensitivity to initial conditions is present some situations. one of them is when the information provided for the person who needs help is not enough, a emerging behavior that cause the ambulance could not be prepared according to the emergency or the corresponding professionals are not provided, also, prank calls might delay the system. This situation could endanger the person. On other hand, traffic congestion is a factor that determines how long the ambulance is delayed in arriving and if also the system is saturated, the response times are affected, putting the patient's life at risk and generating chaos.

However, some of the emerging behaviors have some patterns, that change the chaotic factor in the emerging behavior, for example the traffic jam could have a recurring pattern, and it is possible to predict hours when the street are more congested, therefore, the system saturation could have a pattern

in the days when usually the system is collapsed, and this saturation can be foreseen.

In addition, the system development needs some equipment, but emerging behaviors like mechanic problems or database failures in the hospital could affect the balance in the system, because they are things difficult to repair in the moment and they need special worker to make maintenance.

## IV. CONCLUSIONS

In conclusion, conducting a systemic analysis based on the medical emergency system is a process that requires keeping in mind all the information regarding its functioning and the processes in which it is involved. For this, it is very useful to apply the Top-Down methodology, allowing for the identification of the systems's elements, their relationships, inputs, outputs, emergent behaviors, and environment. Additionally, applying concepts from system theory enables a deeper understanding of how the elements of this system function and interconnect, rather than merely making generalizations, which allows for certain measurements to confirm how well the system operates.

With this in mind, the use of the aforementioned methodology and the concepts of general systems theory allowed for a more specific view of how well the medical emergency system in Colombia functions. This not only involves understanding generalizations and the context of the system but also the functioning of specific elements that help better understand certain components that may not be as visible but are still part of the system.

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