



## A decision support methodology based on AHP to assess state level response to COVID-19 in Brazil

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**Abstract.** The COVID-19 pandemic is considered one of the major sanitary challenges faced by humanity. Due to its high transmissibility, the virus spread quickly through the Brazilian territory. The purpose of this work is to quantify the capacity of response from the Brazilian states in a public health crisis such as the COVID-19 pandemic. This study reports de elaboration of a composite indicator based on the Analytic Hierarchy Process (AHP) methodology. An illustrative application was conducted as a pilot test to validate the assessment framework proposed. The states analyzed were São Paulo, Bahia, and Pará. The specification of this composite indicator can support also benchmarking exercises and the development of action plans to enhance responsivity of the states facing the pandemic.

**Keywords:** Performance assessment, Composite indicators, Analytic hierarchy process, Public Health, COVID-19.

### 1 Introduction

The COVID-19 pandemic reinforces the social differences between developed and sub developed countries, revealing that the maintenance of the health services was more difficult in countries with less developed economies and poor quality of health systems, like Brazil [1].

In Brazil, the responsiveness to the pandemic drastically varies between the regions of the country. In April/2020, the states of *Paraíba (PB)*, *Rio de Janeiro (RJ)* and *Pernambuco (PE)* presented the highest index of lethality by Covid-19 and derived complications. The rates are the following RJ (11.4%), PE (9.09%), and PB (8.8%). On the other hand, the state of Minas Gerais reported values lower than 5% [2].

The analytic hierarchy method (AHP) is the most utilized method in health decision-making problems [3]. AHP was developed by Thomas Saaty in 1970 as a technique to hierarchy goals, criteria, and alternatives to identify the alternative with higher probability to achieve the goal [4].

The purpose of this work is to create a composite performance indicator using AHP for helping in the response of the states of Brazil in the COVID-19 pandemic. A



pilot was executed to compare the response in three different states to prove the efficiency of the indicator.

## 2 Methodology

The composite indicator was developed in four steps: (i) Construction of the theoretical framework; (ii) Variable selection; (iii) Data treatment; (iv) AHP application. During step 1, three criteria were selected: Staff (Amount of workers available per state); Hospitality (Capacity of health systems per state); and Investment (Amount of money allocated by the government in health).

The key performance indicators (KPI's) selected for the construction of the composite indicator were the Number of workers; the Numbers of intensive care units (ICU) beds; the Number of respirators; the Numbers of units of health; and the Amount of money given to the state. The result of the indicator will be the sum of each KPI normalized multiplied by the weight of each criterion and each KPI.

## 3 Results

With the weights of each criterion and indicator, it was possible to calculate the composite indicator for each state. The value discovered represents the capacity of response of each state for a pandemic. A pilot benchmarking was executed with three states, *Pará São Paulo, and Bahia*, which were chosen due to their territorial extension and different characteristics from the region they are localized.

*São Paulo, Bahia, and Pará* reached performance levels of 0.82, 0.69, and 0.67 respectively. *São Paulo* presented the higher score in this illustrative application. This result can be explained by a superior ratio of health care units and the staff ratio observed in SP. Higher ratios of health units and staff per 100,000 inhabitants may explain the better performance of SP. In this specific case, it means that the patient will wait a shorter time waiting for healthcare.

## 4 Conclusions

This study reported initial results of a methodology of assessment of state responsibility in public health crisis scenarios. A composite indicator based on AHP was specified to quantify the Brazilian states responsibility against the COVID-19 pandemic. Initial results confirmed that there is a wide variability in the capacity of states to meet the needs of the population in terms of health care. These results implies that different level of support must be tailored according to the performance of the state. We foresee as future research opportunity, the application of an enhanced version of this method for both state level and municipality levels.

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