

Assessing the COVID-19 Performance Indicators Used in the Portuguese Daily Situation Report

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Abstract—Organizations have been using performance indicators to, amongst others, support decision-making. However, as reported in the literature, there are obstacles to its design and use. This work analysis the Portuguese COVID-19 daily situation report and identifies the 18 performance indicators present in the four page report. Then, it recognizes the more relevant problems associated with its definition and communication, such as, uncertainty of data quality, too many indicators, lack of human resources attached to performance measurement, time and difficulty doing data analysis and lack of time to do data collection, which may limit its use to support decision-making. It ends presenting the requirements that should be fulfilled to reduce the identified problems.

Keywords— COVID-19, performance indicator, performance management, situation report

I. INTRODUCTION

Performance measurement has been gaining increasing recognition of its important role as an element for the effective and efficient management of organizations [1].

Organizations have adopted management practices including the use of Performance Indicators (PIs) [2]. Each organization may use PIs to support decision-making [3]. Additionally, PIs use can support many relevant functions, such as, evaluating the extent to which their goals are being achieved, improving service quality and customer satisfaction, contributing to cost reductions, driving improvement, motivating and compensating people, looking ahead and allowing benchmarking [4, 5].

Performance measurement and management is a relatively recent research topic, not considering the older use of financial PIs. The research developed on this topic was also applied in a variety of companies, such as, from industry to services, from small to large, from private to public and from for profit and nonprofit organizations, spanning different sectors, including the health sector [6-9]. Despite having specific contexts and the possibility of developing performance measurement systems for a specific area, such as a framework to assess hospital performance [10], general recommendations on the use of PIs can be identified. Such recommendations should avoid problems associated to its development and use.

This work's objective is to identify and analyze the PIs used in the reports of the Portuguese Directorate General of Health (DGS) about COVID-19 that were communicated daily through press conferences, and to identify problems with existing PIs based on literature requirements.

The rest of this paper is organized as follows. Section II presents a literature review on PIs, including its limitations and requirements. Section III presents a background of DGS and its COVID-19 daily report, identifying its PIs. Section IV

analyzes the PIs, particularly its limitations and expected requirements. The paper ends with Conclusions and the identification of future research directions.

II. LITERATURE REVIEW

A. Performance Indicator Definition

Performance measure can be defined as metric used to quantify the efficiency and effectiveness of the action [11], and a performance indicator (PI) can be defined as the result of one or a combination of several performance measures. Therefore, one performance measure can also be a PI, and some works do not make an explicit difference between these.

A set of PIs can be combined to create another PI that can be classified as a composite PI; it should measure multidimensional concepts, which cannot be captured by a single PI [12]. The PIs that are critical for the success of the organization are the Key PIs [3].

In interest of simplicity, this work will use the term PI for all of the above-mentioned cases.

B. Problems with Performance Indicators

Considering that PIs can adversely affect performance, to improve the overall efficiency of systems, PIs must be designed, implemented and used assuming that their benefits outweigh their costs [11, 13].

The literature identifies a set of potential obstacles/difficulties on the design of PI:

- Lack of top management interest [14];
- Difficulty in selecting and choosing PIs [11];
- Short-term emphasis on objectives [11];
- Too many PI [15];
- Lack of human resources for this task [16];
- Uncertainty of data quality [18, 19];

Potential obstacles/difficulties on the use of PI are:

- Poorly designed measures encourage undesirable behaviors [17, 20, 21];
- Lack of time to do data collection [22];
- Lack of knowledge/experience of employees [22, 23];
- Time and difficulty doing data analysis [24];
- Some resistance from the "shop floor" personnel [22].

Lopes et al. [19] presented a classification of the uncertainty components or data quality problems associated

with PIs. The developed approach allows identifying the changes that can be introduced in the performance measurement process to obtain more trustable values for the PI used in decision-making.

C. Performance Indicators' Requirements

For performance measurement to be carried out, it is necessary that PIs are designed, implemented, used and reviewed.

Several authors [3, 11, 25-27] have been defining requirements for the design and selection of PIs that are efficient and effective from the point of view of strategic management. These authors suggest that PIs should be transparent, useful, easy to implement, simple to understand, with visual impact, focus on improvement, low cost, and related to the organization's strategy and objectives. A synthesis of requirements to develop good PIs is shown in Table I.

A consensus seems to indicate that PIs should be quantitative and have objective values instead of subjective ones. They should be [27] straightforward and easy to understand to enable a quick identification of what is being measured and how it is being measured; practical with appropriate scales; consistent and maintain meaning over time; and clear on the objectives.

TABLE I. REQUIREMENTS OF PERFORMANCE INDICATORS

Requirement	Description
Derived from strategy and with explicit purpose	PIs need to be positioned in a strategic context, as they influence what people do [11] and managers should use their periodic review sessions to evaluate the validity of the unit's strategy and the quality of its execution [6].
Clearly defined	Performance measurement must be easy to understand [17], having clear and accurate syntax and semantics [3].
Provide timely and accurate feedback	The systems that exist inside or outside the organization may be inadequate to provide accurate timely information necessary to make a good decision because of the inability to quantify or even assess the potential loss [28].
Relevant	Any PI through which organizational improvement or deterioration may be detected is considered a relevant criterion [25]. To keep PIs relevant, an evolution management must be adopted considering PIs' traceability, modification and change propagation [3].
Visual impact	Visual management techniques that integrate strategic and operational perspectives engaging people in a conversation on the strategy and performance of the organization should be applied [20], assuring expressiveness and understandability of the PI [3].
Focus on improvement	The management team must identify improvement opportunities and prioritize changes based on the collective view on the maturity of their performance management practices [28].
Consistent	The PIs must maintain their significance as time goes by [17]. There should be mechanisms to automatically check consistency between the PIs and their related business elements, for a change propagation [3].
Precise	Be exact about what is being measured [17].
Objective	Not based on opinion [17].
Cost effective	It is necessary to check if the data collection process is cost-effective. The data used for the PI may be already part of the process or may need further data collection [25].
Acceptability by user community	Acceptability by user community must be taken into account when implementing PIs [3]. However, we can select a strategy first, and only subsequently working out the relationship with stakeholders [6].

III. THE DGS AND THE COVID-19 SITUATION REPORT

A. Background of DGS

Created in 1899, the Portuguese Directorate General of Health (DGS) [29] has been following the development of the outbreak for the new coronavirus (COVID-19). The country's public health system was activated, with epidemiological monitoring and surveillance, risk management and communication. Among the activities that have been developed, we highlight the first four amongst a list of 13 [29]:

- 1) *Establishment of a team of experts / specialists to respond to the epidemic;*
- 2) *Disclosure of daily communications;*
- 3) *Organization of Press Conferences;*
- 4) *Production and updating of information for the citizen on the DGS website and social networks.*

B. Daily Situation Report

The daily situation report (DSR) is a document available each day on a specific website within the Minister of Health [30]. It is the basis of the information content of daily press conferences and it seems to be the key deliverable of activities 2, 3 and 4 from the above list. It can be argued that the information in this report is similar to a set of PI with the function of monitoring and communicate the COVID-19 situation. It presents the quantitative results of several actions, such as, numbers of tests made or number of patients under intensive care units due to COVID-19.

DSR is published [31] close to lunchtime, with data relative to the previous day. It is a document ranging from 2 to 4 pages, with similar format but with some variations over the days, in the presentation, in the content and in the assumptions underlying its values. Some of the assumptions are related to change in procedures to do COVID tests, source of data, among others.

The following analysis is based on the DSR number 60, published on May 1, 2020. Fig. 1 presents pages 1 and 2 of such report. The analysis recognizes lists, tables, graphs and maps, then the PIs present in these elements are identified.

The first page of the DSR (left side of Fig. 1) has the title "Epidemiological Situation in Portugal".

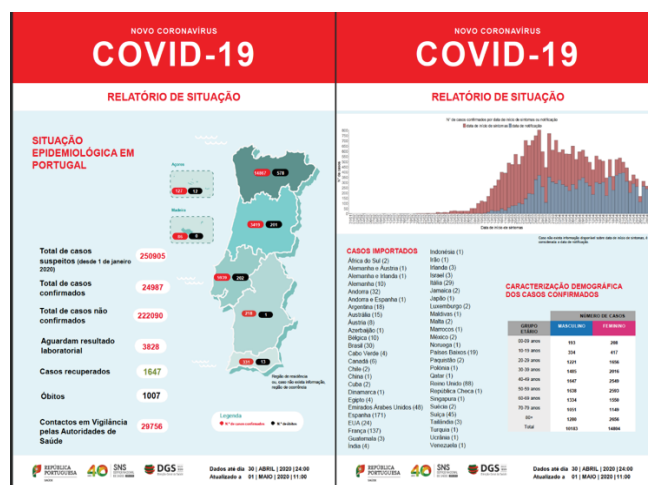


Fig. 1. Pages 1 and 2 of daily situation report number 60, published May 1 on COVID-19 from DGS [32].

On the left side of Fig. 1, there is a list [List 1] followed by an integer number, with three different colors (red, green and black):

- Total suspected cases (since January 1st 2020)
- Total confirmed cases
- Total unconfirmed cases
- Awaiting laboratory results
- Recovered cases
- Deaths
- Contacts under Surveillance by Health Authorities

On the right side of page 1 there is a map of Portugal [Map 1] organized in seven regions (including islands) and in each region there are, according to the subtitle:

- The number of confirmed cases (in red background)
- The number of deaths (in black background).

Close to the map, there is the note: “Region of residence or, if there is no information, region of occurrence”.

On the second page of the DSR (Fig. 1 right side), there is an image with the “Number of cases by the date on beginning of symptoms or notification” [Graph 1]. The scale of number of cases range is 0 to 800 with a resolution of 50, and on the horizontal scale, the day, from January 31 to April 30. In each day, the bar is divided in two with different colors, representing the number of cases with beginning of symptoms and date of notification, with the annotation “If there is no information available on the date of beginning of symptoms, the date of notification is considered.” Thus, the graph shows the number of *new* cases per day, distinguishing if the case was identified on that day or if it was identified on future but attributed to that day because that was the day when the symptoms began.

On the bottom left of page 2 there is a list “imported cases by country” [List 2], with values ranging from one to 171. The list is alphabetically ordered by country.

On the bottom right of page 2 there is a table “Demographic Characterization of Confirmed Cases” [Table 1]. Indicating the number of cases by gender for each of the nine age groups. The last table row contains the total of cases by gender.

Page 3 of the DSR, entitled “Demographic Characterization Of Confirmed Cases”, presents a table with the “Number of Cases by Municipality” (there are 308 in Portugal) [List 3]. There is a note with the following “Methodological notes: The information presented refers to the total of clinical notifications in the *SINAVE* system, corresponding to 85% of confirmed cases. Data are presented by municipality of occurrence in alphabetical order. When confirmed cases are less than 3, for reasons of confidentiality, data are not presented.”

The last page of the report has two titles. The first is “Clinical Characterization of Confirmed Cases,” including:

- One list [List 4] with two items: “Number of Interned Cases” and “Number of Interned Cases in ICU”, with the following note: “Information reported by

Hospitals, Regional Health Administrations and Autonomous Regions”.

- One list [List 5] with symptoms, with the following note: “Reported information regarding symptoms in 86% of confirmed cases: Fever 34%, Cough 44%, Respiratory Difficulty 15%, Headlight 20%, Muscle Aches 25%, Generalized Weakness 18%.

The second title is “Characterization of Occurred Deaths” and contains a table presenting the “Number Of Cases” by gender and by age group, with a last row with the total by gender [Table 2].

C. Identification of Performance Indicators

Using a broader definition of PI, a metric representing the effectiveness or efficiency or action, the following PIs can be identified, because all have associated numbers and a name representing an activity:

- 1) *Total (number of) suspected cases (since January 1st) [List 1]*
- 2) *Total (number of) confirmed cases [List 1]*
- 3) *Total (number of) unconfirmed cases [List 1]*
- 4) *(Number of suspected cases) Awaiting laboratory results [List 1]*
- 5) *(Number of) Recovered cases [List 1]*
- 6) *(Total number of) Deaths [List 1]*
- 7) *(Number of) Contacts under surveillance by health authorities [List 1]*
- 8) *Number of confirmed cases by region [Map 1]*
- 9) *Number of deaths by region [Map 1]*
- 10) *Number of cases by the date on beginning of symptoms or notification [Graph 1]*
- 11) *Number of cases imported by country [List 2]*
- 12) *Number of confirmed cases by gender and by age group [Table 1]*
- 13) *Total number of confirmed of cases by gender [Table 1]*
- 14) *(Number of) confirmed cases by municipality [List 3]*
- 15) *Number of interned cases [List 4]*
- 16) *Number of interned cases in ICU [List 4]*
- 17) *(Number of) Symptoms in 86% of confirmed cases, by symptom [List 5]*
- 18) *Number of deaths, by gender and by age group [Table 2]*

IV. DISCUSSION OF DAILY SITUATION REPORT’S PIS

The discussion will highlight problems with these PI, their apparent requirements and attributes. These will serve to identify limitations of PIs of the DSR. It is assumed that the first step towards change it is the recognition that the current system has flaws and such acknowledge could motivate the design of better PI.

A. Problems with Each Performance Indicator

The problems identified in the literature review, on designing and using PIs will be used to discuss these 18 PIs. The potential obstacles/difficulties on their design are:

- 1) *Lack of top management interest [14]:* the PIs identified are the ones approved by top managers, suggesting

this does not seem to be a problem with the identified PIs. Thus, this problem does not seem relevant for these specific PIs.

2) *Difficulty in selecting and choosing PIs [11]*: by analyzing the DSR it is not available data to discuss this potential problem.

3) *Short-term emphasis on objectives [11]*: in the first DSR's communications through the press conferences, it was stressed that the main objective was to reduce the rate of increase in new cases so that the National Health System had more time to prepare to respond to patients. After a couple of months, this objective seems obsolete.

4) *Too many indicators [15]*: Media does not present all the PIs when reporting the situation. They summarize it using others PIs, thus the ones presented in this report should be a small set.

5) *Uncertainty of data quality [18, 19]*: data source depends on human resources to introduce information on databases and further effort to consolidate such information, e.g., the criterion to classify a death with COVID-19 or by COVID-19 was one example of different interpretations that could result in different values reported.

6) *Lack of human resources [16]*: Some delays in reporting data through the DSR was attributed to lack of time to introduce information in databases. This is one known example but others may be present. Additionally, given quality of the PIs definition and presentation in the DSR, the lack of specialized human resources attached to this task may also be an hypothesis.

The potential obstacles/difficulties on the use of the 18 presented PIs are:

7) *Time and difficulty doing data analysis [24]*: This seems to be a problem since there were many inconsistencies between reports and within the data from the same report, which shows conflicting data. For example, in a given report, the total numbers of deaths by gender is different from the grand total presented in the first page of the report, or the accumulated number of cases in a municipality decreases inexplicably.

8) *Some resistance from the involved personnel [22]*: This potential problem cannot be assessed through the available public information.

9) *Lack of time to do data collection [22]*: the COVID-19 integrated the set of diseases with mandatory reporting. Health practitioners have to notify authorities and spend time recording. This also depends on the computer system, software and communications, which can each one fail and increase the time necessary to introduce data. Finally, when compared with other activities, such as treating a patient, this activity can be perceived as less important. For example, during weekends, because there is less hand-labor the number of tests were smaller than other days and consequently the number of COVID19 positive patients generally decreases on Mondays.

10) *Lack of knowledge and experience of employees [22, 23]*: due to COVID-19 many new rules were deployed during the epidemic, thus to know the applicable protocols and the

guidelines (e.g. to use software) mean that experience may not help when facing new rules and situations.

11) *Poorly designed measures encourage undesirable behaviors [17, 20, 21]*: the use of total numbers instead of relative ones (e.g. per day, per 1000 tests) means that the emphasis is not made on the day the report refers to but to the overall period under analysis, influencing the public perception about COVID-19 risk. To have 1000 deaths in the DSR has different meanings depending on the period it refers to. Additionally, the population that is tested (or not tested due to many factors such as tests' availability) will influence the total number of positive cases.

One typical example of the misinformation based on the defined PIs is presented. Social Media has been highlighting the percentage of new cases over the total accumulated number of cases, which is not a fair comparison (see Fig. 2). In Fig. 2 four boxes named A, B, C, and D were added to highlight the following issues with the PIs of the DSR.

Box A: "This Tuesday Portugal records 1,163 deaths related to Covid-19." This sentence should be corrected to "Portugal registers until this Monday (since the 1st of January 2020) 1,163 deaths related to Covid-19", or "Portugal registers an accumulated total of 1,163 deaths related to Covid-19 between January 1 and yesterday (May 11)".

Box B: "19 more than on Monday": to determine this value it is necessary to get the DSR from Monday and the DSR from Tuesday and calculate the difference between total accumulated deaths reported.

Box C: "In comparison with Monday's data, which recorded 1,144 deaths, today there was an increase of 1.7% of deaths." It is compared the number of deaths in one day with the total accumulated number of deaths in 71 days (i.e. $19/1144 * 100\% = 1.66\%$). However, if the same number of daily deaths was counted after 200 accumulated deaths the result would be an increase of 9.5%, evidencing an inconsistency when interpreting this value.

Box D: "Regarding the number of confirmed cases of infection by the new coronavirus (1,163), DSR data show that there are 234 more cases than on Monday (27,679), representing an increase of 0.8%". This has similar problems to the ones described in Box C. There is the need to look in two different DSR, and the increase in percentage in compared to a total accumulated that represents a period that is increasing every day, so similar number of cases will be represented by different percentages, evidencing an inconsistency when interpreting this value.

Portugal regista esta terça-feira 1.163 mortes relacionadas com a Covid-19, mais 19 do que na segunda-feira, 27.913 infetados (mais 234), segundo o boletim epidemiológico divulgado hoje pela Direção Geral da Saúde (DGS).

Em comparação com os dados de segunda-feira, em que se registavam 1.144 mortos, hoje constatou-se um aumento de óbitos de 1,7%.

Relativamente ao número de casos confirmados de infeção pelo novo coronavírus, 1.163, os dados da DGS revelam que há mais 234 casos do que na segunda-feira (27.679), representando uma subida de 0,8%.

Fig. 2. Highlight in one major media station (SIC) on COVID-19, based on the DGS daily situation report of Tuesday May 12th 2020. Source: adapted from [33].

B. Requirements Fulfilled by Each Performance Indicator

A subset of requirements (R) identified in the literature, selected by the authors and more relevant to this specific context will be used to discuss these PI:

R1 - Derived from strategy and with an explicit purpose

R2 - Clearly defined

R3 - Provide timely and accurate feedback

R4 - Visual impact

R5 - Focus on improvement

R6 - Consistent

R7 - Precise

R8 - Cost effective

Table II presents the perception of authors, as experts on performance measurement and as individual recipients of the information conveyed through the DSR. Except for R8 that the authors do not have sufficient information to make an informed assessment, PIs do not fulfill all the identified requirements, i.e. PIs are incompletely defined. For example, let us discuss requirements 1 to 7, for PI_9 - number of deaths per region.

1) It can be induced that this PI should provide public awareness from a specific region about the severity of the disease. However, depending on the type of people affected (for example, young vs old people or healthy vs non-healthy people) and the availability of public care (speed of emergency response and proximity to hospitals with available capacity) may affect this PI.

TABLE II. REQUIREMENTS FULFILLED BY EACH PI

Performance Indicator	R1	R2	R3	R4	R5	R6	R7	R8
1. Total (number of) suspected cases		⊙						○
2. Total (number of) confirmed cases	○	⊙						⊙
3. Total (number of) unconfirmed cases	○	⊙						○
4. (Number of cases) awaiting laboratory results		⊙				⊙		○
5. (Total number of) recovered cases	⊙	⊙						⊙
6. (Total number of) deaths	○	⊙	⊙	⊙			⊙	●
7. (Number of) contacts under surveillance by health authorities	⊙	⊙			⊙	⊙		○
8. (Total) number of confirmed cases by region	○	⊙		⊙				⊙
9. (Total) number of deaths by region	⊙	●	⊙	⊙		⊙	⊙	●
10. Number of cases by the date on beginning of symptoms or notification	⊙	⊙		●	⊙	⊙		○
11. (Total) number of cases imported by country		⊙						○
12. (Total) number of confirmed cases by gender and by age group	⊙	⊙						○
13. Total number of confirmed of cases by gender	⊙	●						○
14. (Number of) confirmed cases by municipality	⊙	⊙	⊙				⊙	○
15. Number of interned cases	⊙	⊙	⊙			●	⊙	●
16. Number of interned cases in ICU	⊙	●	⊙	⊙		⊙	⊙	●
17. (Percentage of) symptoms in 86% of confirmed cases, by symptom	○							○
18. (Total) number of deaths, by gender and by age group	⊙	●					⊙	●

●- requirement met; ⊙- requirement partially met; ○- insufficient data

2) The number of deaths means that the cause of death is related to COVID-19. So, if a patient dies without doing the test, it may have died due to COVID-19 and not being recorded. additionally, if he makes the test, but due to test errors (procedure used, materials used, method of analysis)

the results result could be misleading. There is also the case of other factors that may have influenced the death, and in Portugal, if the patient has COVID-19, the minister of Health stated the patient would counts as a “COVID-19 death”, which is different by the classification used normally. The PI has to be determined by region and the address registered may not correspond to the current place of living.

3) Unavailability of tests could cause delays and lack of time to introduce data in databases may also be relevant.

4) This is a cumulative indicator, starting at zero, providing no awareness in public before first death and after many deaths, the current situation is not properly reported since the accumulated number refers to the past.

5) A graph of the daily evolution of this PI is not be provided and the identification tendencies or the achievement of targets is also not done.

6) There were changes in the criteria to do tests and in the availability of tests, suggesting that deaths may have occurred without being tested for COVID-19.

7) The tests' precision is not determined/known.

Overall, as can be seen in Table II, some requirements such as R2 and R1 are met or partly met by many PIs, while other requirements such as R3 to R7 are met only by a small proportion of PIs. Requirement 2 is considered met or partially met by the majority of PIs (except PI 17). This was considered by the authors based on the name of the PI. Requirement 1 also can be considered partly met by many PIs, since through the press conferences some PIs' objectives were explained.

The majority of the PIs does not comply with “provide timely and accurate feedback”, “visual impact” and “focus on improvement”. To have focus on improvement, PI's purpose should be clear and controllable actions to improve such PI, should be defined. To have visual impact the PI should be shown with relative numbers, so that they can be comparable. Timely feedback, is critical to support decisions to be made by the health authorities, the government and the public, but is not achieved when there is evidence about delays: in introducing data, delays accessing to COVID tests, delays when potential patients try to contact the DGS, putting test results into databases, etc. Accurate feedback is not guaranteed, since there were changes in procedures over time regarding approaches to detect potential patients and to do screening tests, changes in the types of testes used, etc.

V. CONCLUSIONS

Considering the definition of PI, the DSR was analyzed and 18 PIs were identified. Based on the literature review, the authors identified and discussed common problems with PIs, suggesting the limitations of the DSR's PI. Accordingly, the most relevant problems are identified, supporting previous works findings: uncertainty of data quality [18, 19]; too many indicators [15]; lack of human resources attached to performance measurement; time and difficulty doing data analysis [24]; lack of time to do data collection [22]; and poorly designed measures encourage undesirable behaviors [17, 20, 21].

The tests used to identify patients with COVI-19 have different characteristics, undetermined error rates, limited availability, and the criteria to select people to do the test has changed over time. Thus, it can be concluded that data quality on “total number of confirmed cases (with COVID-19)”

should be further analyzed and, as a result, PI interpretation could change.

The requirements that PIs of the DSR should follow are synthesized from the literature review. The requirements more relevant for this context were defined and the existing PIs, do not fulfill, them. Overall, the 18 PIs of the DSR do not comply with requirements: provide timely and accurate feedback [28]; provide visual impact [3, 20]; and focus on improvement [28].

To fulfill its functions, PIs need to be well designed, implemented, used, and reviewed [34]. PIs should support, amongst other functions, decisions to act on controllable processes to improve results, but even simple requirements such as using relative numbers over absolute one to make comparisons were not verified.

As a limitation of this work, part of the discussion is based on authors' perceptions/ judgement based on public available information. Nevertheless, the authors belong to the public target of DSR and are experts on performance measurement, through its application in different contexts.

One future research direction is the design of new PIs to meet the identified requirements and avoiding the limitations exposed in the used ones. This research could also be expanded by including DGS's stakeholders to identify new requirements and to make contributions to their design.

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