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ORIGINAL ARTICLE

Methodological Framework for Assessing the Performance of Health Statistics Information Systems in Cuba

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ABSTRACT

Introduction: health information systems are an essential component for evidence-based decision-making and the digital transformation of the healthcare sector. Within these systems, Health Statistical Information Systems play a critical role in generating data on morbidity, mortality, health services, and related processes.
Objective: to design a methodological framework to assess the performance of health statistical information systems in Cuba.
Methods: a technological and methodological development study was conducted, grounded in a document review and analysis of international reference frameworks: the Pan American Health Organization's IS4H-MM maturity model, the PRISM framework, and current national regulations and standards. Unstructured expert consultation and modeling methods were employed to structure all components of the proposal.
Results: a multidimensional assessment framework was established, encompassing data sources, information products, quality and interoperability standards, governance, and Information Technology infrastructure. This framework is organized into five progressive maturity levels (Initiated, Developing, Defined, Integrated, and Optimized Integrated). The instrument operationalizes the evaluation through qualitative and quantitative items and outlines an analytical procedure to yield a gap profile and an overall weighted index.
Conclusions: the developed methodological framework provides a flexible, contextualized, and action-oriented tool for diagnosing the state of health statistical information systems in Cuba, enabling the identification of operational gaps and guiding continuous improvement in healthcare delivery.

Keywords: Health Information Systems; Data Management; Medical Informatics; Decision Making.

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INTRODUCTION

Health technology is understood to mean the set of medicines, equipment, devices, procedures, organizational systems and information systems that are used in health care and management. The incorporation and use of these technologies require evaluations that verify the effectiveness, safety, efficiency and equity with which they are used. The World Health Organization (WHO) and the Pan American Health Organization (PAHO) have institutionalized the Health Technology Assessment (ETS) as a key process to guide the decisions of health systems.[1]

For decades, the notion of health technology was associated with medicines, medical devices and clinical procedures. However, PAHO promotes a vision of health information systems (IS4H) as an essential component of the sector's digital transformation and a condition for evidence-based decision-making. [2,3] SISs are not just administrative tools: they produce the information that supports attention, surveillance, planning and policymaking.

Within the SIS, the Statistical Information Systems in Health (SIES) perform critical functions. They are the main mechanisms for generating data on morbidity, mortality, resources and services. These systems support epidemiological surveillance, by allowing the detection of events and a timely response. In addition, they support the planning and allocation of resources with criteria of efficiency and equity and provide the evidence to evaluate policies, programs and services. [4]

A poor information system can lead to wrong decisions that affect entire populations. Hence, the periodic evaluation of these is as necessary as that of any other health technology. The performance of SISs is the degree to which these systems meet the information objectives in terms of opportunity and reliability that improve decision-making and the functioning of the health system as a whole. A well-designed SIS not only collects information, but processes it and makes it available to decision-makers to optimize the quality, efficiency and effectiveness of services. [5,6]

The evaluation of that performance requires multidimensional frameworks that go beyond isolated technical measurements. Currently, there are several international frameworks that recognize this need and propose ways to carry it out, such as the framework and standards for national health information systems of the WHO Health Metrics Network (HMN), the PRISM framework for the design, strengthening and evaluation of routine health information systems, or the PAHO maturity model (IS4H-MM).[7]

In Cuba, the SIES develop in a regulatory framework that defines who produces the information, how they should protect themselves and what the State should guarantee. For a diagnosis of the state of these systems, that network is the reference criterion against which the practice is contrasted. This framework includes Law 165 of Public Health,[8] which updates the governance and digital transformation of the sector, the subsystem of statistical health information (SSIES) directed by MINSAP through systems and records; Law 149/2022 on Protection of Personal Data,[9] vital to protect sensitive patient information; and the set of decrees and regulations on computerization, telecommunications and cybersecurity (decrees-laws 370/2018 35/2021 and Res. Ministry of Public Health 2/2026 (is the General Regulation for the digital transformation of the SNS), which set the requirements of infrastructure, interoperability and institutional responsibility in technological management.

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As a whole, this framework makes it possible to formulate verifiable evaluation criteria ranging from legal requirements and data protection to technological infrastructure and statistical architecture. Although there are various international frameworks for the evaluation of the performance of the SIS, they often fail to capture the operational and organizational particularities of the Cuban context. For this reason, it is imperative to develop a specific evaluation framework that fits the national reality. A process conceived as a comprehensive diagnosis aimed at identifying gaps and guiding decision-making in environments of limited resources.

To operationalize this approach, this study aims to design a methodological framework for the diagnosis of the performance of Cuba's statistical health information systems.

METHODS

A technological and methodological development research was developed oriented to the design and structuring of a methodological framework for the diagnosis of the performance of the SIES in the Cuban context. The investigation was carried out between May 2025 and September 2026.

A comprehensive review of the international scientific and technical literature was carried out, with emphasis on key methodological references for the evaluation of routine health information systems. The guidelines and architecture of the PAHO/WHO health information systems maturity model (IS4H-MM) [7] and the PRISM (Performance of Routine Information) framework, [10] were studied with the purpose of integrating a staggered development structure with an evidence-based practical verification methodology. Likewise, the normative documents, methodological guidelines and national regulations in force governing the management of the SIES and the statistical system in the public health sector were systematically reviewed, which made it possible to establish the reference criteria against which institutional practice is contrasted.

In the process of designing and refining the instrument, 14 specialists in the field of medical records, statistics and health technologies were consulted in an unstructured way. These were interviewed in an unstructured way. This exchange made it possible to capture the operational specificities, organizational restrictions and real needs of the Cuban care environment that had to be represented in the dimensions and evaluation items. These consultations were carried out iteratively and on demand, as doubts or specific needs arose during the modeling of the framework.

Modeling was used as the main method to integrate, derive and articulate the components of the framework. Through a process of abstraction and synthesis, the multidimensional matrix was structured that crosses five dimensions of analysis with five levels of progressive maturity. In addition, the analytical scoring rules, consolidation thresholds and the mathematical formula for the calculation of the Global Performance Index (GDI) were modeled, which configured a comprehensive, descriptive and action-oriented methodological procedure.

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RESULTS

Need to diagnose the performance of SIES

Health information is a strategic resource, but the value it can generate depends on the quality, opportunity and effective use of it. Among the problems that may limit the performance of the SIES are:

- Duplication and fragmentation of sources, which generate inconsistencies and increase the workload of staff.
- Delays in the delivery of data that prevent timely response to health events or planning decisions.
- Low statistical quality, due to under-registration of data, interpretation and coding errors, lack of standardization and absence of systematic validation.
- Low use of information in decision-making, due to the lack of access to data in appropriate formats for users.

In the Cuban context, these problems can arise given the features of the current SIES: the coexistence of manual and digital records, connectivity and equipment limitations, and the need to integrate multiple sources within a very extensive system. At the same time, the country has an accumulated strategic value, which is a long tradition of health records and statistics with national coverage, and with a recent regulatory framework that raises the requirements on information and protection.

Under such conditions, the performance evaluation should not be considered as an audit or as an isolated compliance control, but as a diagnosis of the state of the system. Diagnosis is distinguished from other forms of evaluation by three features:

1. It is descriptive and explanatory: it establishes how the system is today and why, not only if it complies or does not comply.
2. It is multidimensional: it considers governance, data, technology, processes and the use of information at the same time.
3. It is action-oriented: it concludes in prioritized gaps and recommendations, and can be repeated over time to measure progress.

Diagnosing the performance of the SIES allows, therefore, detecting weaknesses, checking the degree of application of the current regulatory framework and proposing well-founded improvements, which strengthens the ability of the health system to decide with evidence.

Methodological framework for the diagnosis of SIES performance

The methodological framework presented was designed to diagnose the state of Cuban SIES. It is organized in a matrix of five maturity levels by five dimensions, derived in indicators that are explored by verification questions that are answered with three options: yes, partial or no.

The design responds to two complementary logics. The first is that of the maturity models, and of them, the IS4H-MM of PAHO/WHO:[7] a staggered structure that allows to place the system in a stage of development and know what is missing to move to the next. The second is the practical evaluation of routine health information systems. For this, the PRISM framework was taken:[10] questions that contrast with evidence, in which it is almost always indicated which document, record or series should be requested and what proportion defines each answer.

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Multidimensional structure

It is composed of five dimensions, where each examines a component of the system and is linked to references of the Cuban framework, so that the diagnosis verifies not only the technical performance, but also the effective application of the rules. (Table 1).

Table 1. Dimensions of the methodological framework for the diagnosis of the performance of the SIES in Cuba

Dimension	What explores?
Data sources	Availability of forms, control of reception of primary records, agreements with the areas that report, coverage of the reporting centers and completeness of the data.
Information products	Sending reports according to calendar, agreement with the data noted, requests for objection, bulletins, use of information in decision-making and indicators in the Health Statistical Yearbook.
Quality and interoperability standards	Current version of the ICD-10, nomenclator of the SIE and coder of the political-administrative division; knowledge and compliance with standards; consistency checks; interoperability between records.
Data governance	Information calendar, manuals and circulars, user identification, instances of quality discussion, training and metadata.
IT Infrastructure (Information Technology)	Connectivity, computer program for registration, technical support, spreadsheets and databases, backup and security.

Levels of maturity

Each level groups questions of the five dimensions and describes a more advanced state of development than the previous one. These levels are in direct correspondence with the IS4H-MM.[7] (Table 2).

Table 2. Levels of maturity of the methodological framework for the diagnosis of the performance of the SIES in Cuba

Level	What characterizes it?	Questions
I. Initiate	Minimum system conditions: available forms, reception control, calendar reports, standards received, regulatory documents, connectivity, basic computer program and technical support	15 (3 per dimension)
II. In development	Coverage of informants and completeness of data, initial use of information, defined basic standards, punctual verifications, informal instances of quality and consolidation with spreadsheets	15 (3 per dimension)
III. Well-defined	Systematic collection by electronic means, regular dissemination to the authorities, formal standards plans, documentation of procedures, metadata, databases and evidence of interoperability	15 (3 per dimension)
IV. Integrated	Interoperability between institutions and levels, near real-time update, external audits, online boards, international standards and automated backup	20 (4 per dimension)
V. Integrated optimized	Real-time data, predictive analysis, automatic alerts, external interoperability certification, advanced cybersecurity and permanent monitoring	24 (5 per dimension, 4 in standards)

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The methodological framework is operationalized through an instrument that contains 89 questions. Levels I to III describe conditions that can be achieved by management systems predominantly on paper or with basic computerization, and are the most accurate: all level I questions and most of those at levels II and III indicate how to rate the answer. Levels IV and V describe reference states, still far away for paper systems, and serve to mark the horizon of development (Supplementary Material 1).

Application and scoring

The diagnosis is developed in three steps:

- Delimitation: the SIES, subsystem or registry that is evaluated and the unit where it is applied are defined.
- Collection of evidence: the evaluator applies the instrument together with the technician who carries the system, through documentary review (calendars, manuals, circulars, bulletins), verification of records and chronological series, and interviews. The evidence is noted in the observations column.
- Rating: each question is rated "yes", "partial" or "no" according to the criteria of the guide. When the question does not bring criteria, a general rule applies: "yes" if it is fulfilled and demonstrated with evidence; "partial" if it is only partially fulfilled or the evidence is incomplete; "no" if it is not fulfilled or cannot be proven.

Score:

It is proposed to assign 1 point to each "yes" answer, 0.5 to each "partial" and 0 to each "no". The fulfillment of dimension d at level n is:

$$C = \frac{S + 0{,}5 * P}{N} * 100$$

Where C is the fulfillment of the dimension, S is the number of answers "yes", P the number of answers "partial", and N the number of questions of that dimension at that level.

A level is considered consolidated when compliance (C) reaches at least 80 % and all lower levels are also consolidated. If k is the number of levels consolidated consecutively from level I, the dimension is at level k + 1. With three questions per dimension, the 80 % threshold requires at most one partial answer. The maturity of the dimension (M) is expressed on a continuous scale from 0 to 5, which adds up the consolidated levels and the progress towards the following:

$$M = k + \frac{C + 1}{100}$$

The global performance index (GDI) integrates the five dimensions of the methodological framework:

$$IGD = \frac{100}{5} \sum w * M$$

With w = 0.20 for each dimension as initial weighting, which must be validated by consulting specialists. The IGD goes from 0 to 100. The overall level is read on the same five-level scale of the instrument (Table 3). Supplementary Material 2 shows an example of the application and interpretation of the designed framework.

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Table 3. Classification and interpretation of the Global SIES Performance Index

IGD	Global level	Interpretation
0 a 19,9	I. Initiate	Minimum conditions still to be consolidated
20 a 39,9	II. In development	Minimum conditions consolidated in essence; incipient coverage and use
40 a 59,9	III. Well-defined	Systematic and documented processes, with electronic support
60 a 79,9	IV. Integrated	Interoperable systems and wide dissemination
80 a 100	V. Integrated optimized	Continuous improvement, real-time data and advanced analysis

DISCUSSION

The evaluation of the SIS has ceased to be conceived as a mere control of technical compliance to consolidate itself in a strategic pillar of health governance and digital transformation. D'Agostino et al.,[3] point out that the design of information systems must be critically analyzed from the perspective of public policies and the operational needs of health services.

In this sense, this work bases and proposes a methodological framework for the diagnosis of the performance of the SIES, structured through a five-level maturity model operationalized through an instrument of 89 items. The relevance and implications of the main methodological choices adopted in this design are analyzed in the light of recent scientific literature.

One of the fundamental methodological decisions of this study was to raise the evaluation in the transition from a punitive audit to a descriptive, explanatory and action-oriented diagnostic process. Contemporary literature on health technology management and digital health supports this paradigm shift. Recent research on the evaluation of maturity in health systems, Gomes et al.,[11] shows that complex health organizations require tools that guide continuous improvement and strategic planning, rather than punitive metrics that generate operational resistance.

Conceiving that the diagnosis is multidimensional, the proposed framework aligns with the premise that routine health information systems (SRIS) operate in complex socio-technical environments. Various authors have emphasized that the adoption of technologies and data flows in health often fails when software or media are evaluated in isolation, without considering the dynamics of human and organizational processes. Therefore, the approach adopted allows the establishment of a realistic baseline on which health units can identify gaps and structure staggered pathways for improvement.[12,13,14,15]

The choice to integrate a staggered structure of five levels of maturity responds to the fundamental principle that organizational and technological development does not occur in a linear or spontaneous way, but through progressive phases of capacity building. To this end, a denomination of the levels identical to that used by the maturity model of health information systems of PAHO (IS4H-MM) was adopted, so that a conceptual standardization and comparability in qualitative terms with regional references were achieved, even if in its operational and analytical architecture the evaluation criteria differ due to the adaptation made.

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However, a risk documented in the recent literature, according to Cresswell et al.,[16] is that many international models of digital maturity are designed for high-income environments or networks with high levels of digitization. This imposes decontextualized technological requirements that are inapplicable in realities with limited resources and mixed infrastructure. Hence, there is a need to provide a contextualized framework to the Cuban information system.

In addition, within the methodological framework presented, the initial levels (Levels I to III) are calibrated to capture and assess the basic conditions of management systems predominantly on paper or with elementary computerization. This is in line with the findings of Kawakyu et al.,[17] who, when refining the PRISM framework, emphasize that assessment tools must adapt to local operational capabilities and start from where the health provider is located, so that the value of traditional manual records is recognized before requiring advanced interoperability or systems with integrated artificial intelligence.

The study by Luna et al.,[18] on the evaluation of health systems highlights that governance, human resources and public policy frameworks are as decisive for the success of an SIS as the technological infrastructure itself. The inclusion of governance and quality and interoperability standards as cross-cutting dimensions reflects the understanding that the quality of information depends on the normalization of processes and institutional commitment.

On the other hand, the dimensions related to infrastructure elements balance the evaluation by recognizing the realities of resources, connectivity and technical support, to avoid technocentric biases. Current literature emphasizes that the sustainability of health information systems depends on the harmonization between available infrastructure and actual local support capabilities.[19,20]

As part of the future prospects and the next steps in the operationalization of this proposal, it is essential to carry out a rigorous phase of empirical validation through specialist consensus methods, in addition to the pilot implementation in different health units and levels of care. These actions will allow the consolidation thresholds to be accurately calibrated, the weights assigned to be verified and the operational applicability of the instrument under real working conditions.

CONCLUSIONS

The methodological framework presented, which is organized into five dimensions and five levels of maturity, creates the basis for diagnosing the state of SIES in Cuban conditions. As future lines of work, it is proposed to validate the consolidation threshold and weightings with specialists, and to carry out a pilot application in selected subsystems.

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Conflicts of interest
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Contribution of the authors
CRAI: Conceptualization, Formal analysis, Research, Methodology, Writing – original draft, Writing – revision and editing.
MdCRM: Conceptualization, Formal analysis, Research, Methodology, Supervision, Writing – original draft.
MEPL: Conceptualization, Formal analysis, Research, Methodology, Supervision, Writing – original draft.
MLIS: Validation, View, Writing – revision and editing.
WSS: Validation, View, Writing – revision and editing.

Statement on the use of artificial intelligence
During the preparation of this work, the authors used Claude Sonnet 5.5, from the supplier Anthropic, with the aim of improving the writing and grammar of the text, as well as to support the translation of bibliographic sources consulted. Subsequently, the authors thoroughly reviewed, edited and validated the generated content, assuming full and total responsibility for the final manuscript.

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