

# Proposal for a Global Indicator in the Area of Quality, Safety, Environment and Health (QSMS) for Analysis of a Company in the Oil and Gas Segment

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Quality, Health, Safety, and Environment (QHSE) management is essential for all companies, especially service providers. Besides operating within their own facilities, they also work in external units of contracting companies. This work aims to propose global indicators by segment (QHSE) and a global indicator for the integrated system and monitor its efficiency and evolution over time. For this purpose, a case study was analyzed in a repair, maintenance, and inspection service company in the oil segment, operating in Brazil. The prioritization of criteria and subdivision of indicators was carried out by a team of company specialists using the Weighted Sum Method (WSM) decision-making technique. The intention was to obtain a systemic view of the results of global indicators by segment (QHSE) through data collection, identifying points of greater relevance for the company, and proposing recommendations to increase the company's efficiency. The proposed global indicators allow assessing the organization's performance, enabling the identification and dissemination of best management practices for the Integrated Management System (IMS). In the analysis of the results using data from 2021 to 2022, it is observed that the use of the proposed global indicators met the needs of the management system. Keywords: Performance indicator. Global Indicator. QSMS. Integrated management system. Weighted Sum Method.

## 1. Introduction

The Integrated Management System aims to meet the need that organizations have to integrate business management: quality, environment, health, and safety at work. In this sense, companies focus on satisfying and retaining their customers, surpassing their expectations and needs. Garza-Reyes *et al* (2018), researching 119 Chinese industrial companies, showed that, in general, there is less awareness TQEM in the Chinese industrial sector than other approaches to environmental and quality/operations improvement, such as green supply chain management, reverse logistics, and ISO 9000. Regarding the monitoring of management system efficiency using global indicators, the work of Figueiredo *et al* (2020) addresses the use of the Weighted Sum Method (WSM) combined with the Analytic Hierarchy Process (AHP) in determining global indicators for environmental management. In this work, environmental indicators were subdivided into two main groups: those related to environmental quality and those related to environmental performance. These two indicators were estimated using WSM. The global indicator used AHP. Also, in the line of global indicators, Silvestri A. and colleagues (2021) presented the use of the guidelines recommended by the ABNT ISO 31000 standard in identifying global performance indicators for integrated systems. As reported in the work, the new method, called the Global Performance Index for Integrated Management Systems - GPI-IMS, was applied to a real case study in the logistics area to assess its quality and allow the definition of requirements to achieve the best performance. In addition to the above-mentioned works, Ebrahim Tehrani and Izadshenasan (2019) and Lundgren *et al* (2019) proposed indicators related to the determination of performance evaluation models in maintenance, monitoring

the effectiveness of an integrated health, safety, and environment system. They relied on anomaly reports and performance indicators to assess the effectiveness of intelligent maintenance utilization.

## 2. Case study

The analyzed company is a multinational Inspection, Repair, and Maintenance company operating in the oil and gas sector. It has its Integrated Management System (IMS) certified to ISO 9001, ISO 14001 and ISO 45001 standards and is structured to meet contracts involving operations of small, medium, and large complexity, at national and global levels. It has approximately 340 employees in Brazil. All its codes are disclosed by employees via an electronic portal and are considered in the company's policy, endorsed by senior management. The critical analysis of the IMS is conducted through external audits. Non-conformities are identified, and action plans are structured, with the establishment of goals to be achieved in the respective indicators.

### 2.1 Identification of indicators practiced in the company

Tables 1-4 refer to the performance indicators for each segment collected during the studied period.

*Table 1: Safety performance indicators.*

Acronym	Indicator	Definition	Goal	Classification
TFCA	Licensed attendance fee	Indicates the number of lost-time accidents that occur for every million man-hours of exposure to risk in the period considered	Analyze the frequency rate of lost-time accidents	Reactive
TFSA	License-free attendance fee	Indicates the number of accidents without lost time that occur for each million man-hours of exposure to risk in the period considered.	Analyze the frequency rate of lost-time accidents,	Reactive
TG	Severity Rate	Represents the number of days lost and charged to the Organization in a period of one million man-hours of exposure to risk	Analyze the severity rate,	Reactive
YOU	Incident rate	It is the sum of typical cases of non-lost-time injuries, including first aid, lost-time injuries and fatal accidents per million man-hours worked	Analyze recordable incident occurrence rate, targets and comparison	Reactive

*Table 2: Quality performance indicators.*

Acronym	Indicator	Definition	Goal	Classification
ISC	Customer Satisfaction Index	Carry out your operations with integrity, to achieve full customer satisfaction, preserving trust in your operations	Measure the quality of services provided	Proactive
IAR	Audit Index	Relationship between the audits carried out and the goals established through the audit schedule	Monitor compliance with the pre-established audit schedule	Proactive
INC.	Non-Conformity Index	Serious Nonconformity Index, opportunities for improvement and customer complaints	Measure compliance in processes within the established deadline	Proactive

.Table 3: Environmental performance indicators.

Acronym	Indicator	Definition	Goal	Classification
ICE	Electricity Consumption Index	Monitor electricity consumption in the installation	Monitor the company's performance in managing electricity consumption	Reactive
NAA	Environmental Accident Number	Evaluates the number of environmental accidents registered with environmental agencies	Effectiveness of the environmental licensing management process in accordance with ISO 14001	Reactive
RTG	Total Waste Generated	Total mass in kg according to pre-established target	Monitor the company's performance in the generation of solid waste	Reactive

Table 4: Health performance indicators.

Acronym	Indicator	Definition	Goal	Classification
NS	Number of health incidents	Accident, which causes bodily injuries, which prevents the injured party from returning to work the day immediately following the accident	Analyze the number of lost-time accidents, goals and comparison	Reactive

Source: Internal company data.

## 2.1 Application of the Weighted Sum Method (MSP) in determining the global indicators by segment and the global indicator of the integrated system

The evaluation of the indicators concerning the subcriteria was conducted using the MSP tool. Its calculation is obtained according to the work of Figueiredo *et al* (2020).

Equation 1 shows the MSP:

$$f(x) = \sum_{i=1}^n w_i f_i(x) \quad (1)$$

Where:

$$\sum_{i=1}^n w_i = 1$$

$f(x)$  is the multi-attribute function for alternative  $x$ ,  $n$  is the number of criteria and  $w_i$  is the weight of criterion  $i$ ,  $f_i(x)$  is the value attributed to alternative  $x$  considering criterion  $i$ .

The assessment of the weight of each indicator ranges from 1 to 5, with 1 being adopted when there is no relevance between the indicator and the subcriterion, and 5 when there is high relevance. In this context, relevance can be understood as impact or effect, as presented in Table 5.

Table 5: Criteria for determining the Weights used to prioritize indicators.

Criterion	Weight	Justifications
There is no relevance	0.1 - 1.0	The indicator derives from subjective assessments or has a history of low frequency of occurrence
Relevant	1.1 - 3.0	The indicator results from objective assessments with less severity
Very relevant	3.1 - 5.0	The indicator is based on objective assessments with high severity

Source: The author.

Regarding the scores, as shown in Table 6, their performance ranges were adjusted to a range from 0 to 10, where in the range from 1.0 to 2.5 the indicators are not relevant, and in the range from 7.6 to 10, they are highly

relevant, as presented in Table 7. It was necessary to define the range from 1 to 10 to keep the indicators equivalent.

Table 6: Notes used to validate the indicators.

Criterion	Observation	Justifications
Not relevant	1.0 - 2.5	The proposed indicator has no relevance in the composition of a global indicator.
Low relevance	2.6 - 5.0	The proposed indicator has low relevance in the composition of a global indicator, although related to the risk area
Medium relevance	5.1 - 7.5	The proposed indicator is important in the composition of a risk area related to the global indicator
High Relevance	7.6 - 10	The proposed indicator is very relevant in the composition of a global indicator related to the risk area

Source: The author.

This method allows separate evaluations of criteria that indicate the relevance of each indicator through scores. The higher these factors, the greater the relative importance of that specific indicator. The operation of the method is simple. In determining the weights, an average value obtained by the application of a questionnaire where the indicators were shown, and the respondents assigned a weight, was used. For each of the indicators used by the company, the following attributes were considered: Direct relationship with training by the contractor; Direct relationship with meeting the schedule; Interference in the final cost of the activity; Direct relationship with training by the company; Direct relationship with the image of the contractor; Direct relationship with the image of the client.

After data collection, they were placed in two spreadsheets. One for prioritizing the indicators that composed the global sub-indicators and a second one for prioritizing the global sub-indicators for generating the overall indicator. These spreadsheets were sent to various employees of the company to determine the weights to be assigned to each of the indicators that make up each of the subgroups (Quality, environment, health, and safety). After identifying the global sub-indicators, the second spreadsheet was sent, enabling the structuring of the equation for the Global Performance Indicator.

Table 7: Criteria for defining the weight range.

Criterion	Weight range	Justifications
There is no relevance	0.1-1.0	The indicator derives from subjective assessments or has a history of low frequency of occurrence
Relevant	1.1-3.0	The indicator results from objective assessments with less severity
Very relevant	3.1-5.0	The indicator is based on objective assessments with high severity

The partial global indicators in the areas of Quality, Health, Safety, and Environment were calculated from the sum of the products of each indicator with its respective prioritization, using the MSP technique, as shown in Equation 2.

$$IDGI = x_1 \times \text{Indicator}_1 + x_2 \times \text{Indicator}_2 + \dots + x_n \times \text{Indicator}_n \quad (2)$$

Where:

$$x_1 + x_2 + \dots + x_n = 1$$

$$x_i = (w_i N) / \text{Total}$$

IDG1 – Global Performance Indicator for subgroup  $i$ ,

IDGMA – Global Environmental Performance Indicator.

IDGSS - Global Health and Safety Performance Indicator.

IDGQ - Global Quality Performance Indicator.

The same procedure used to calculate the global indicators for each subgroup was adopted to determine the Global Performance Indicator.

### 3. Results and discussions

Below are presented the data related to the generation of coefficients and the behavior of the respective partial global indicators and the overall global indicator. For this purpose, data referring to the indicators composing each of the respective global indicators were considered over a period of 3 years (2020, 2021, and 2022).

a) Global Quality Performance Indicator (IDGQ, in portuguese)

Adopting the results of the prioritization of these indicators in Equation 2 of the IDGQ, the following equation 3 was obtained:

$$\text{IDGQ} = 0.398 \times \text{ISC} + 0.244 \times \text{IAR} + 0.357 \times \text{INC} \quad (3)$$

b) Global Environmental Performance Indicator (IDGMA, in portuguese)

In the same way as seen in IDGQ, adopting the results of the prioritization of these indicators in Equation 2 of IDGMA, the following equation 4 was obtained:

$$\text{IDGMA} = 0.274 \times \text{ICEP} + 0.389 \times \text{NAA} + 0.337 \times \text{RTG} \quad (4)$$

c) Global Health and Safety Performance Indicator (IDGSS, in portuguese)

The same methodology was used to calculate the IDGSS, adopting the results of prioritizing these indicators in the IDGSS Equation, the following equation 5 was obtained:

$$\text{IDGSS} = 0.283 \times \text{TFCA} + 0.243 \times \text{TFSA} + 0.253 \times \text{TI} + 0.253 \times \text{NOS} + 0.250 \times \text{TG} \quad (5)$$

d) Integrated System Global Performance Indicator (IDG, in portuguese)

As proposed in this work, in addition to establishing performance indicators for each of the areas that make up the integrated management system, the same tool was used to structure the Global Performance Indicator, associating the three determined indicators (IDGA/IDGMA and IDGSS). For this, the same structure of weights and notes was used. The same attributes were considered both in the generation of weights and in the generation of scores, as shown in table 7. In this way, the calculation of the global QMS integrated management indicator (IDG) was carried out, with their respective prioritizations, as shown in equation 6

$$\text{IDG} = 0.21 \times \text{IDGMA} + 0.27 \times \text{IDGSS} + \dots + 0.24 \times (1 - \text{IDGQ}) \quad (6)$$

### 4. Conclusion and recommendations

As described, the company monitors the integrated system through several indicators. As a way of acting, it sets more restrictive targets for certain specific indicators and for each of the respective segments. As this work included global indicators by segment and a global indicator of partial indicators by area and the global indicator, it is possible to establish global goals seeking to achieve all indicators that make up each one with partial global indicators, as shown in Table 8 presented below

Table 8: Performance ranges for all Indicators.

Resource	Compliance with quality standards			
	Low	Normal	High	Sustainable
Interaction	Inactive	Reactive	Confidential	Proactive
IDGQ	0.81 +/- 3Dp	0.81 +/- 2 SD	0.81 +/- 1 SD	0.81
IDGMA	0.51 +/- 3 SD	0.51 +/- 2SD	0.51 +/- 1 SD	0.51
IDGSSO	0.40 +/- 3Dp	0.40 +/- 2 SD	0.40 +/- 1 SD	0.40
IDG	0.26 +/- 3 SD	0.26 +/- 2SD	0.26 +/- 1 SD	0.26

The methodology applied made it possible to measure the performance of global indicators over a given period (from 2020 to 2022). From this same perspective, it appears that the use of the proposed global indicators successfully responds to the proposed needs, so that there is a continuous evolution of the incorporated data, of the analysis mechanisms, in order to maintain the characteristics achieved and thus allow monitoring the sensitivity and robustness of the integrated management system. Furthermore, performance indicators can significantly improve the management process by outlining the management profile of the quality of services provided. Proposed global indicators simplify the analysis of SGI behavior, quantifying concepts for establishing goals in order to minimize the generation of environmental impacts, increasing the quality of services and

enabling greater control over the safety of its operations, allowing the execution of actions and projects in the oil and gas sector, in order to articulate concepts of quality, safety, environment and health, helping to identify and disseminate the best management practices of the integrated management system.

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