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Descriptive Model of Indicators for Environment, Health and Safety Management

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Management of systems requires, amongst many other things, a thorough and continuous understanding of the actual system's state and its development trends. To do so, managers need to rely on both descriptive and explicative models of the system's strengths and weaknesses. One of the means to do so are indicators.
Widely developed in all areas of management (financial, economic, logistics), Environment Health and Safety (EHS), seen by management science, are also to be approached using indicators.
One can find in literature multiple references and guidelines on how to develop and/or use indicators for EHS management. Without being exhaustive, OECD, IAEA, and CCPS are examples of well known international guidelines suggesting indicators for various or specific business areas regarding all or some of the EHS dimensions. In this paper, we will see that it is particularly difficult for decision makers to select the right indicators for their organization amongst dozens of various references and hundreds of indicators. We will also see that the main difficulty in this selection process is the multiple dimensions to be considered when assessing the relevance of an indicator.
As a first answer, this paper will suggest a formal descriptive model of an EHS indicator. This model will present what we consider as necessary descriptive features for every EHS indicator so to help decision makers answering a simple question: is this indicator good or not for my organization?

1. Introduction

Indicators can be defined as subjective mental constructions aiming to capture one or several aspects of reality considered of importance when it comes to a specific subject (Mazri et al, 2011). In our particular case, the specific objects are the EHS performances of industrial systems already characterized in literature as complex (Hopkins, 2007).
In other words, one can say that we are using subjective and very partial tools to approach complex systems that may threaten huge human, environmental and economic stakes. Once we said that, the reader can easily understand that using and interpreting indicators should be handled very carefully.
Consequently, managers, being in charge of defining, using and interpreting those indicators in everyday EHS management need to be supported so to avoid multiple potential misuses already well acknowledged in literature (Wiedemann and Gray, 1997).
In order to provide this decision support, this paper will first describe more in depth the challenges and opportunities related to the use of EHS indicators. From that, core issues to be resolved when selecting indicators will be deducted. Finally, we will suggest a descriptive model to be used by managers to fully describe an indicator, and thus, support them in selecting an adequate set of EHS indicators.

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2. EHS indicators: challenges and opportunities

Indicators are meant to provide a synthetic and action oriented knowledge. Those potentialities offer interesting opportunities for EHS managers that can be synthesised as follows.

2.1 Improve monitoring frequency

By providing regularly an updated description of the system, indicators allow managers to refresh their system's representation.

Actually, safety reports required by Seveso directive provide, or at least should, a thorough but static description of the system generating the risk. This description is a fundamental starting point to identify and correctly shape both technical and organizational devices for risk management.

Nevertheless, this description can be quickly overwhelmed by multiple explicit and/or hidden evolutions of both technical and organizational dimensions of the systems.

For instance, gaps between official procedures and real practices are classical deviations that can challenge hypotheses and conclusions adopted within the safety report.

By implementing relevant indicators, those gaps can be detected and either the practices or the procedures be corrected.

2.2 Make better use of information already collected for other purposes

Survival of organizations rely on their ability to collect in a systematic and organized way the information and knowledge about its environment on one hand and their own performances on the other hand.

Therefore, a great amount of information is usually collected by organizations for various purposes: quality management, financial management, human resources management…

As stated in (HSE, 2006), developing relevant safety indicators helps rationalization of information management by avoiding collection of useless information and making better use of the ones already collected and considered as necessary.

To materialize those opportunities and reach real improvements in EHS management, managers need to overcome some challenges that we tried to list below.

2.3 Scope effect

As stated previously, indicators reflect only limited aspects of a complex reality. Therefore, managers will naturally pay a greater attention to those aspects. With an unchanged amount of resources, other aspects of reality will mathematically be under considered. A good example of this mechanism was provided by the BP Texas city accident. Management has developed and implemented indicators dedicated to workplace safety and considered them as representative of the global safety performance of the system (Baker panel report, 2007). By basing their representation on this subset of numbers, managers were unable to draw a broader picture that includes other aspects of safety.

This example shows that if wrongly used, indicators may mislead managers instead of enlighten them.

For those reasons, scope effect is to be considered as an unwelcomed side effect of using indicators.

Tackling this issue requires for managers to correctly understand the strengths and weaknesses of the various indicators they are using. In other words, purposes and limits of each indicator should be well acknowledged so their users know which aspects of their system are monitored and which are not.

Once those strengths and limits well understood, one can think about the complementarities between different indicators. Actually, if different indicators may separately reflect different aspects of a system, together they can cover several aspects. We will talk here about a network of indicators which complementarities make it realizable to cover all dimensions of a system.

To do so, managers should be offered not only a list of candidate indicators; but also a list of complementary indicators that considered together will constitute a network capable of a satisfactory description of a system.

2.4 Organizational reluctance

Managers should be aware that each management tool introduced in an organization contributes to modify it and is, in return, modified by the organization (Hatchuel and Molet, 1986).

Indicators are no exceptions. Therefore, a first condition to ensure their usefulness and added value for management is to be positively perceived and accepted by the organization.

Otherwise, and in the lack of workforce commitment, there is a big risk to develop indicators that do not reflect reality. Many mechanisms can explain this lack of commitment:

- An indicator may be considered as useless by those in charge of providing data;
- Not enough resources to perform required tasks, especially if field observations are necessary;
- Lack of reporting culture within the organization;
- Distrust of the working force towards the management.

Once again, the direct consequence will be for managers to have misleading indicators that do not reflect the reality of practices and system's strengths and weaknesses.

2.5 How many indicators are necessary?

Selecting a set of EHS indicators is about finding the adequate balance between representativeness in one hand and feasibility on the other. Representativeness points the ability of the set of indicators to correctly reflect the various aspects of reality related to a system. Feasibility, on the contrary, tends to limit the number of indicators so to lighten the burden they may represent for the organization.

Actually, using and communicating indicators may generate important costs for organization:

- One or several persons may be required to ensure that data are collected according to a code of practice associated to the indicator. This code of practice should at least describe the frequency and procedure of data gathering; especially if those data rely on field observations.
- Regularly, indicators should be questioned to check their relevance regarding system's evolutions.
- In order to ensure a continuous commitment of workforce and first line management to correctly report the required data for EHS indicators, regular information should be provided by management on the relevance and added value associated to those indicators.

In this search for equilibrium, managers have to ensure on one side that they do not dismiss an important aspect of EHS management that will leave important parameters out of the management system. On the other side, they also need to minimize the number of indicators, or at least, to dimension this number according to the reporting capacities and practices of their organization. Practices amongst companies may highly vary. There is no standard of the adequate number of indicators for EHS management. This is why finding this balance should be done according to the each system specificities, making it the direct responsibility of EHS managers.

According to the various challenges and opportunities described above, a list of core questions and needs, required by managers to correctly perform this difficult selection can be summarized as follows:

- Which aspects of reality are captured by the indicator and which are still unrevealed?
- Is this candidate indicator relevant when considered alone or should it be considered as part of a network of indicators?
- What will be the cost of this candidate indicator for my organization?
- Do we have all the adequate skills to correctly use and interpret this candidate indicator?

As a methodological answer, a descriptive model of EHS indicators is described in the followings.

3. Descriptive model of EHS indicators

A descriptive model of EHS indicators aims to list the features to be systematically described to support managers in the process of defining and selecting relevant EHS indicators for their organization.

As mentioned earlier, many questions are raised during such a process. By providing all the informative elements to answer those questions, EHS managers will be able to better legitimate the choice of some candidate indicators instead of others in one hand and better manage the life cycle of the chosen indicators.

Once the candidate indicator selected, the way it will be organizationally and technically implemented is still to be defined. Especially, the responsibilities and resources devoted to data collection, indicator calculation, communication and interpretation have to be defined without ambiguity. Finally, the relevance of this indicator should be regularly challenged regarding the system's evolutions.

For all those reasons, regular and updated information about the way the indicator is evolving within the organization need to be gathered and stored. This descriptive model offers this opportunity and can consequently be considered also as a tool to manage the set of EHS indicators during their life cycle.

Actually, according to management science, the model to be detailed below can be considered as a knowledge management model since it aims at collecting, organizing and sharing a set of action oriented information. However, it is important to remind that this model does not provide any guideline or methodology on how to identify the EHS needs in terms of indicators. 0ne can find multiple references for various types of approaches in Oien et al (2011) and HSE (2006). To adequately describe an EHS indicator, it is suggested to respect the followings items.

3.1 Item 1: General information

For a manager who already identified the EHS dimensions that he is interested in monitoring, this first item aims to answer the following question “Does this indicator match my needs?”
The information to be provided here are described in the table below.

Table 1: Detailed sections of the “General information” item

General Information	
Short Name	Codified and unique name of the indicator
Long name	Detailed name of the indicator
Description and purpose	Whatever is the quality of an indicator, it rarely captures all aspects of a reality. What an indicator does and what it does not should thus be clearly described.
Source	Who issued this indicator?
References	Reference document(s) describing the indicator.
Nature	An indicator can be qualitative, semi quantitative or quantitative.
Risk dimensions covered	In this paper, we focused our attention on Environment, Health and Safety. Nevertheless, depending on the system’s needs and the management systems implemented, additional or modified dimensions can be considered. For example, one can choose to explicitly distinguish workplace safety from process safety, or to define a Corporate Social Responsibility dimension that will include both environment and workplace safety (ISO 26000, 2010). Dimensions definition being open, future users should nevertheless acknowledge that a unique indicator may be more or less relevant for several dimensions.

3.2 Item 2: Technical features

If according to information given in item 1, manager(s) believe an indicator as interesting, the next step is to understand its technical features. In other terms, this second step will answer the question “*How does it work?*” We suggest defining the technical features of an indicator through the following sections

Table 2: Detailed sections of the “Technical features” item

Technical features	
Formula and unit	Qualitative or quantitative formula to calculate values taken by the indicator should be provided.
Target value	Some indicators may monitor the ability of a system to reach a predefined performance which, in this case, will represent a target value.
Minimal and maximal values	Describe the upper and lower limits within which the values taken by the indicator are considered as acceptable. Out of those limits, actions are to be taken.
Input data required	Data required to implement the formula described above have to be listed here.
Frequency of measurement	How often should we measure this indicator? The periodicity of monitoring will influence on the level of resources required.
Related indicators	As stated earlier, indicators should be considered within networks so to take profit of their complementarities. Therefore, a list of indicators that may provide additional knowledge should be suggested to the manager.

3.3 Item 3: Organizational features

Thanks to g*eneral information* and *technical features* items, the manager knows now what the candidate indicator can describe and how to technically implement it.
The next question to be answered is: *What is the cost of this candidate indicator for my organization*?
The idea here is to help managers appreciating the balance between the cost of using an indicator in one hand and the benefits in terms of insights about the system's evolution on the other hand.
To summarize, two main categories of costs can be considered here. The first is related to the consumption of human resources: technical and administrative procedures, interpretation and communication of the indicator's results. The second category is related to the additional costs required to collect missing input data or to reformulate those delivered by the organization's information system.
The first category of costs will be detailed within this item, the second within the next one (*information technology item*).

Table 3 Detailed sections of the "Organizational features" item.

Organizational features	
Indicator reference person	A reference person in the organization should be affected to each indicator. This person will be in charge of ensuring the quality of the whole process from data collection to interpretation and communication of the results.
Data providers	According to the list of input data described within the technical features, persons in capacity of delivering those data need to be clearly identified.
Interpretation procedure	Interpreting values taken by an indicator is a decisive phase. Persons required to correctly interpret and use insights provided by this indicator should be identified.
Communication procedure	Persons within and outside the organization that should be informed about the monitoring results have to be identified as well as the method and the communication channels to be used.
Relevance assessment procedure	Because of the natural organizational evolutions and risk profile modifications of every system, the relevance of an indicator needs to be regularly questioned according to a well defined procedure.

3.4 Item 4: Information technology features

This item aims to evaluate the concordance level between input data requirements in one hand and the data provided by the organization's information system.

Table 4 Detailed sections of the "Information technology" item.

Information technology features	
Software availability	Managers may be interested in knowing if existing software may facilitate the use of the indicator, and hence, reduce its costs.
Adequacy with local information system	The configuration of existing information system may facilitate, or on the contrary, complicate the process of input data collection. The best configuration would be that all input data are already treated by the information system for other purposes.

The descriptive model of an EHS indicator presented above appeals some complementary remarks:

- The identification of needs in terms of EHS monitoring should be performed before using this model.
- The various items presented are to be considered according to a chronological order. Acknowledging the scope and limits of an indicator firstly and describing its technical features secondly will help managers to assess its relevance and its operational conditions of use.
- According to this assessment, one can define the best organizational configuration to assess the expected costs of using this indicator.

- By providing a common template for EHS indicators for all kind of systems, this model will enhance exchange of experiences and best practices through different industries. Managers will appreciate the possibilities of adapting proven good practices in other type of systems.

4. Conclusions

The management of systems appeals necessary the development of monitoring approaches.
This paper tries to suggest a model describing major aspects related to the life cycle of an EHS indicator. It tries also to offer decision makers the opportunity to insert their indicators within a coherent and complementary monitoring system composed by network of indicators.
For the sake of clarity, this model has been described through four distinct items to be considered through a chronological order. Those items guide the user through an exploration process of the various dimensions of an EHS indicator.
Future users should feel free to use additional items to better fit their expectations. For instance, this model has been used in the European project *Integrisk* (Mazri et al., 2011) to elaborate a Key performance indicators database for emerging risks. The description of indicators in this database has been enhanced for the project purposes by adding additional items: the type of industry in which the indicator is classically used or developed, the aspects of risk governance captured (Technology, Human and organisational, communication and regulation), the products' life cycle phases in which the indicator is to be used (Design, Manufacturing, use/operation, end of life). Nevertheless, we consider that the four items presented are the minimum set of descriptive features to be used by managers within a global approach of defining an EHS monitoring policy.

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