



Occupational Health Maturity by Combined AHP and Fuzzy Comprehensive Evaluation Methods

Latifa Fertat and Abdelghani Cherkaoui

EMISys Energetic, Mechanical & Industrial Systems, Engineering 3S research center, Industrial Engineering Department, Mohammadia Engineers School (EMI) Mohammed V University, Rabat, Morocco

Correspondence should be addressed to: Latifa FERTAT; latifa.fertat@gmail.com

Received date: 28 August 2017; Accepted date: 23 November 2017; Published date: 5 February 2018

Academic Editor: Aymen Ammari

Copyright © 2018. Latifa Fertat and Abdelghani Cherkaoui . Distributed under Creative Commons CC-BY 4.0

Abstract

Occupational Health and Safety OHS is becoming necessary to manage sustainable performance in the enterprise. Executives are seeking efficient systems to manage global performance and steer their strategic goals. That's why centered human factors' systems are needed. A global OHS vision helps executives and managers to evaluate at first their OHS maturity through different management levels, and secondly make the right decisions to develop their OHS strategy for better performance: OHS maturity in strategic management level, in HR management dimension and finally in operational management. A combined AHP and Fuzzy comprehensive evaluation method is used to challenge the established OHS maturity model. By this way, the model is scientifically stronger that converts qualitative data collected from experts to quantitative ones.

Keywords: Fuzzy, AHP method, OHS Occupational Health and Safety, Maturity matrix

Introduction

Measuring the global performance of a company is steering its effectiveness and its attractiveness, hence also measuring the

health of its employees. In the book *Managing the Risk of Workplace Stress* by David J. Cooper (2004), steering performance without considering the human factors dimension keeps from seeing the global

image of company's health and other impacting levers. Indeed, OHS is a multidisciplinary field concerning activities and work environment risks according to S. D. Summerhayes in *Design Risk Management: Contribution to Health and Safety* (2010).

Depending on the adherence degree to OHS, it can be in the first step a measure to satisfy standards and local regulation. In a second step it can be a simple marketing lever to improve company's attractiveness. Finally, F. Székely mentioned in *European Management Journal* (2005) that the long-term approach consists on considering the OHS as a strategic tool of sustainable and global performance.

Indeed, occupational health intervention is not only about improving conditions and workplaces, but it aims to improve productivity and make performance more sustainable as mentioned by A. J. Oswald, E. Proto, and D. Sgroi in *Happiness and Productivity* (2014), also by G. Spreitzer, C. Porath in *Harvard Business Review* (2012), and by P. Garibaldi, J. O. Martins, J. V. Ours in *Ageing, Health, and Productivity* (2011).

It is common that an employee in good health performs better, especially when risk activities are controlled and human factors capacities and limits are taken into consideration (David J. Cooper (2004)).

This research will highlight the contribution of OHS and make it a priority in decider's agendas to invest more in human factors.

That's why it is interesting to study OHS maturity to 1) determine the gaps compared to international standards in terms of OHS practices 2) set a development roadmap to improve one enterprise OHS maturity 3) and finally maintain a continuous improvement by monitoring and reengineering OHS indicators.

Our maturity evaluation model is about 1) categorizing Key Performance Indicators KPI

that impact OHS according to the literature and OHS experts 2) weighting these indicators according to AHP method 3) evaluating maturity level of a company according to Fuzzy comprehensive evaluation method 3) illustrating the impacting levers of OHS and suggesting an action plan to enhance OHS maturity.

Occupational Health Maturity

Literature Review

According to International Labor Organization ILO, a worker dies every 15 seconds (more than 2.3 million deaths every year) from a work disease or simply an occupational accident. These statistics are scaring and must be taken seriously into consideration.

On the one hand, these absences and sick leaves are a big cost to the companies. In the other hand, 4% of global Gross Domestic Product is the estimated cost of the OHS poor practices according to C. Clarke, C. L. Cooper in *Managing the risk of workplace stress* (2004).

Visibly, there is an emerging opportunity to enhance company's maturity in terms of OHS. Unfortunately in many countries talking OHS in the company is just unimaginable, it depends closely on the culture of the company that is in most of times a top down culture as mentioned by J. Purcell in *People management and performance* (2008).

On the other hand, enhancing work conditions improves global performance and develops a sustainable vision. Indeed, F. Székely affirmed in *European Management Journal* (2005) an organization that manages better the human factors dimension can give a big push up to the company's efficiency and attractiveness.

According to European Agency for Safety and Health at Work (1999, the economic effects of occupational safety and health in the Member States of the European Union -

Bilbao, European Agency), stress costs 20 Billion euros a year in European Union. It is also a source of about 60% of non working days. In 200, stress was the first cause of sick leave according to the same source.

Even if the economic considerations are not pushed forward, they are usually taken into consideration when new measures and practices of OHS are opted for. In Europe, these measures are rising thanks to high requirements of protecting employers and regulations.

Some countries such as the UK are opting for raising public policy awareness about OHS positive impact. Other countries such as Finland and Netherland are putting their efforts into developing instruments to assess costs and benefits to encourage OHS. The ethical and responsibility levels are also rising.

Today, the awareness about the OHS question is raising and companies are more receptive about upgrading their OHS maturity and this is a positive point. And what makes things easier for decision makers is to have the right tools to evaluate their maturity first and then steering their performance by KPIs involving OHS dimension.

It is interesting to cite GRI standards in sustainability KPIs that covers many dimensions of the organization and their interaction with the environment especially some of OHS indicators. GRI is a rich referential of global reporting in many activity sectors (M. Arnaboldi, G. Azzone, M. Giorgino in Performance Measurement and Management for Engineers (2015)).

According to World Health Organization WHO, occupational health deals with workplace aspects of safety and focus on first-degree prevention of identified hazards. The safety and health of employees have several determinants. For examples, accidents, workplace's risk factors that can cause cancers, musculoskeletal, respiratory,

hearing loss, circulatory and communicable diseases, and disorders caused by stress.

Maturity Matrix

As stated by HSL, Health and Safety Laboratory, Occupational Health Management refers to: preventing workers from suffering adverse effects on their health caused by their job, by avoiding or controlling risks through task and worker adaptation.

IOSH, the Institution of Occupational Safety and Health, as the biggest professional health and safety membership organization, organized OHS maturity survey by HSL. What is interesting in their approach is the evaluated dimensions. It concerns Business beliefs, Fairness, Mindful, Collective Responsibility, Leadership and Learning maturity levels.

A study of HSE (Health and Safety Executive) about Occupational health provision on the Olympic Park and athletes' village in collaboration with ODA Olympic Delivery Authority 2012, Focused on other aspects of OHS. They were interested to workplace, workers, and well-being dimensions to measure the OHS maturity.

Finally, Regional health agency ARS made a state of the art of occupational health management in the Ile-de-France healthcare establishments. This study is axed on different processes of OHS: 1) How deep the OHS processes are institutionalized 2) How is OHS taken into account in work activities 3) How is OHS risks prevention managed and steered. This approach is axed mainly on operational management level of OHS.

What is interesting here is comparing different levels of evaluating OHS maturity according to the aim and context of each study. It also depends on the final supplier of the maturity evaluation.

In our study we defined different levels of

maturity evaluation axed on a global view of the company and its interaction with their environments including strategy's level which is more exhaustive and defines a global view of performance. This level of evaluation explains how top down OHS strategy can create sustainable performance, and how efficient can culture change be in institutionalizing new practices in OHS. That's why the involvement of executives in this project is highly recommended as mentioned by A. Mazur in "Model of OHS Management Systems in an Excellent Company" research (2015).

The established maturity matrix is destined to decision makers and executives to be used as a strategic lever of management:

First of all, we focus on strategy management aspects especially management style, leadership, culture and values in the company and its relationship to sustainability as developed by J. Purcell, N. Kinnie, J. Swart, B. Rayton, S. Hutchinson in People management and performance (2008).

Strategy defines the culture and values of the company that's why it is interesting to evaluate OHS maturity from top to down management as mentioned by J. Purcell in People management and performance (2008).

Indeed, according to J. P. Helfer, M. Kalika, J. Orsoni in Management, Strategy and Organization (2010), if executives are aware about the positive impact of developing an OHS strategy, things go easier and sponsorship of the OHS project is guaranteed. Executives and leaders are by nature the key actors of strategic change.

At a second level, we focus on Human Resources Management HRM, especially how careers are managed, how we can evaluate the company's social climate, and how deep is awareness to wellness at work (A. Mazur in "Model of OHS Management Systems in an Excellent Company" research (2015)).

Indeed, Human Resources Management is a source of value creation and has as aim to optimize intern resources as mentioned by R. J. Burke, C. L. Cooper in Building more effective organizations: HR management and performance in practice (2007). After the last financial crisis, social responsibility is promoted and traditional practices in HR management are questioned. So today we talk about Stakeholders instead of Shareholders. It means that the enterprise has to develop its social responsibility (C. Boyd in Human resource management and occupational health and safety (2003)). In other words, the immaterial resources are considered as a wealth and a competitive advantage for the company as mentioned by A. Dietrich, F. Pigeyre in Human Resources Management (2005). So we can talk about social performance instead of economic performance as a restrictive way to evaluate effectiveness and attractiveness.

Finally, we evaluate operational management aspects, which are the traditional level in OHS diagnostic. For example, work conditions as workplace ergonomics, risk and safety management and all the devices used to manage work accidents and prevention, without missing the evaluation of the performance system and analyze the steering systems to monitor activities and measure keys of performance as productivity and effectiveness. (M. Arnaboldi, G. Azzone, M. Giorgino in Performance Measurement and Management for Engineers (2015) and F. Djellal, F. Gallouj in Measuring and improving productivity in services (2008)).

In the next paragraph we will explain the methodology we follow to develop our OHS maturity matrix.

Methodology

AHP method

In order to evaluate the importance of each index of OHS maturity evaluation and prioritize them, we will use the Analytic Hierarchy Process (AHP) method. It is a mathematic model based on Multi Criteria

decision-making method to organize and analyze complex decisions from subjective data. It is also called scales method for comparison. That's what Han Li, Mei Qiang, Lu Yu-mei developed in Analysis and Study on AHP-the Fuzzy Comprehensive Evaluation Method, China Journal of Safety Science (2004).

To compare criteria, we use consistence matrix of binary comparison. However, due to human subjectivity, AHP method tolerates relatively small inconsistency in human judgment usually provided by expert

reviews.

AHP in our case is used to weight and define the priority order of the overall evaluation areas of OHS in the company called first class indexes, and KPIs in each evaluation area also called second-class indexes.

Fuzzy Evaluation Method

Principals of comprehensive fuzzy evaluation will be used to define the membership of OHS maturity matrix which is in the fuzzy evaluation method the evaluation matrix R_{ijk} :

$$R_{ijk} = \begin{bmatrix} r_{i11} & r_{i12} & \dots & r_{i1m} \\ \vdots & \vdots & \ddots & \vdots \\ r_{ij1} & r_{ij2} & \dots & r_{ijm} \end{bmatrix} \quad (1)$$

Where $k = 1, 2, \dots, m$, m is the evaluation level, i is the class indexes number, and j is the second indexes number (Wang Jian, Xu Ya-bo in Application of Fuzzy Mathematics, Safety Evaluation, Theory and Research 2 (2005)). The second-class indexes are ranked by

importance degree according to the judgment matrix. This matrix is set using 1-9 scale method also named Saaty scale, weight vector W_{ij} , and membership matrix R_{ik} of each second class index are got from the equation:

(\circ is the fuzzy operator)

$$R_{ij} = W_{ij} \circ R_{ijk} \quad (2)$$

$$[w_{i1} \ w_{i2} \ \dots \ w_{im}] \circ \begin{bmatrix} r_{i11} & r_{i12} & \dots & r_{i1m} \\ \vdots & \vdots & \ddots & \vdots \\ r_{ij1} & r_{ij2} & \dots & r_{ijm} \end{bmatrix} = [r_{i1} \ r_{i2} \ \dots \ r_{im}] \quad (3)$$

Model Conception

The Occupational Health and Safety maturity index evaluation is build from a global view of the different impacting indicators including different levels of managing OHS in a structure whatever is the nature of its business or its organization: Strategic management M_1 , Human Resources

management M_2 , and Operational management M_3 (see Table 1).

M_i are the first class indexes and M_{ij} are the second class indexes. Each index is evaluated from a lower to a higher level of OHS maturity, using fuzzy method (Zhang Jun, Yang Wei-ping, Yang Li-gong in Application of Fuzzy Comprehensive Evaluation (2011)):

$$V = \{\text{Institutionalized; Advanced; Basic; Absent}\}$$

Each level's meaning is fully explained in Figure 1, from an operational level to a strategic one.

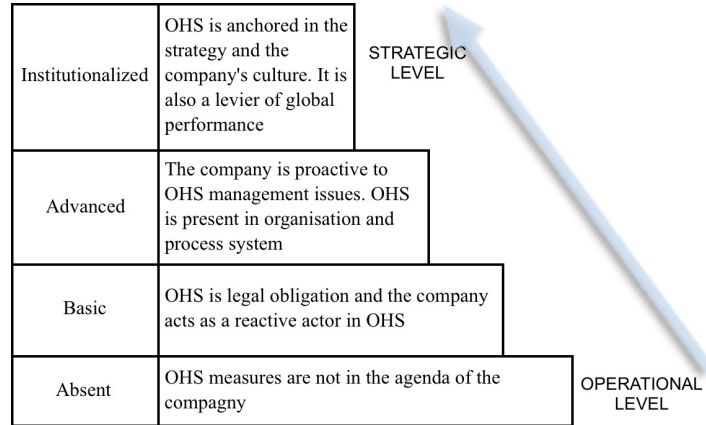


Fig. 1: OHS Maturity

Application Case

Our theoretical model has been applied in a service company context involving OHS

experts and different management levels. The data case is shown below:

The weight and membership results of the second-class index are shown in Table 2.

Table 1: Occupational Health Maturity Index Evaluation

| Maturity level | Overall evaluation area | KPIs of the area |
|-------------------------------------|-----------------------------|---------------------------------|
| OHS maturity level (M) | Strategic management (M1) | Sustainability management (M11) |
| | | Organization (M12) |
| | | Culture (M13) |
| | | Change management (M14) |
| | HR management (M2) | Career management (M21) |
| | | Social climate (M22) |
| | | Wellness management (M23) |
| | Operational management (M3) | Work conditions (M31) |
| | | Risk management (M32) |
| | | Safety management (M33) |
| Performance management system (M34) | | |

Table 2: Weight and Membership Results of the Second Class Index

| 1st class index | 2nd class index | Weight | Level | | | |
|-----------------|-----------------|----------|-------------------|----------|-------|--------|
| | | | Institutionalized | Advanced | Basic | Absent |
| M_i | M_{ij} | W_{ij} | | | | |
| M1 | M11 | 0,4239 | 0 | 0,1 | 0,5 | 0,4 |
| | M12 | 0,0835 | 0 | 0,7 | 0,3 | 0 |
| | M13 | 0,2873 | 0 | 0,4 | 0,6 | 0 |
| | M14 | 0,2053 | 0,4 | 0,6 | 0 | 0 |
| M2 | M21 | 0,2249 | 0,4 | 0,6 | 0 | 0 |
| | M22 | 0,3545 | 0 | 0,2 | 0,8 | 0 |
| | M23 | 0,4206 | 0 | 0 | 0,6 | 0,4 |
| M3 | M31 | 0,2412 | 0 | 0,3 | 0,7 | 0 |
| | M32 | 0,0930 | 0 | 0,2 | 0,6 | 0,2 |
| | M33 | 0,2852 | 0 | 0,2 | 0,8 | 0 |
| | M34 | 0,3806 | 0,2 | 0,5 | 0,3 | 0 |

The first class index membership by fuzzy comprehensive evaluation and the weights of the first class index are shown in Table 3.

After the application of our OHS maturity evaluation model, we reach these results:

Let's put M as the vector of OHS maturity level, $M=WR$.

W is the first class index vector

R is the first class index membership matrix (see Table 3)

Numerically, we get the value of OHS maturity level like that:

$$M=(0,0817; 0,2942; 0,5304; 0,0817)$$

Table 3: Maturity level membership matrix of the first class index

| Ri | Wi weight | Institutionalized | Advanced | Basic | Absent |
|-----------|------------------|--------------------------|-----------------|--------------|---------------|
| M1 | 0,1667 | 0,0821 | 0,3390 | 0,4094 | 0,1696 |
| M2 | 0,3333 | 0,0899 | 0,2058 | 0,5360 | 0,1683 |
| M3 | 0,5000 | 0,0761 | 0,3383 | 0,5670 | 0,0186 |

Results Analysis

First lecture of the results and according to the maximum membership degree principle, the OHS maturity of this company is “basic” which means that OHS is only here to respond to legal obligation, so the company acts as a reactive actor in OHS to external constraints and structuring problems with high impact.

As a recommendation, we suggest adopting transformation program to reengineer the existent processes. This program has as an aim to inject human factors in the structures of the company. In practice, redesign KPIs by injecting OHS indicators to both monitoring and improving sustainable performance. It is also necessary to set a coaching program to accompany the leaders, executives and middle management to lead the culture change and institutionalize the new practices and measures around Occupational Health and Safety. This change will also impact positively the strategy of branding beyond the positive impact on business goals.

On the other hand, we observe that the most impacting factor that has the highest weight is operational management factor especially the performance management system. That means production system and how it is monitored are reflecting OHS maturity. Indeed, this level reflects how deep executives are sensitive to human factors dimension and shows the gap between the current production system and standards in OHS.

Well, to improve OHS maturity, we should focus on work conditions and risk

management system because they are impacting levers to enhance OHS in operational management system. We can also improve safety management and develop performance system by including global performance concept.

Global performance guaranties a sustainable effectiveness and attractiveness if OHS is integrated to business strategy.

Conclusion

This study has as a major aim to highlight the positive impact of centered human factors strategy and change the received ideas of executives and decision makers about Occupational Health and Safety.

To institutionalize OHS best practices, we need a long-term culture change but the benefit is recognized in a short term.

Combining the fuzzy evaluation method and AHP method is a strong way to talk about OHS maturity with more scientific argument and less subjectivity.

This model’s strength lies in its scalability, it can be used in other maturity evaluation processes especially continual improvement process and quality approaches.

This model can also be used in different activity domains, in industry or in service sectors, only the used survey can be adapted to each context, which is a part of a preparative analysis to the OHS maturity program.

Otherwise, this scientific model will encourage decision makers to support OHS as a priority in performance system and enhance the importance of human factors in

management systems. In these conditions, we are going towards a sustainable performance.

As a perspective, we can experiment this model by using other scientific methods such as entropy method (Zhao Guang-jin, Research on Mine Enterprise's Safety Management Based on Entropy Theory (2012) and Qiu Wan-hua, Liu Bei-shang, Hou Lin-lin in REM Assembly Based on the Reliability of Entropy, Systems Engineering (2008)) to determine indexes weightings of the OHS maturity matrix, by using the information system data of the company instead of interviewing experts. This experimentation will allow a comparison between the objective data source and the subjective one and watch the impact in final result.

Acknowledgements

A special acknowledgement to IST Institut universitaire romand de Santé au Travail which coaches me about practices in Occupational Health and Safety, and different issues experienced in their missions.

References

1. Arnaboldi, M., Azzone, G. and Giorgino, M. (2015), "Value Drivers," in *Performance Measurement and Management for Engineers*, 1st ed. London, UK: Elsevier, ch. 4, sec. 1, pp. 51-57.
2. Boyd, C. (2003), "Mapping the OHS Landscape, Human resource management and occupational health and safety" in *Human resource management and occupational health and safety*: Routledge Taylor & Francis Group, NY, USA.
3. Burke, R. J. and Cooper, C. L. (2007), "Treating people right," in *Building more effective organizations: HR management and performance in practice*: Cambridge University Press, UK, pp 21-22
4. Clarke, C. and Cooper, C. L. (2004), "Costs associated with occupational stress, Absenteeism, turnover and productivity, Work-related accidents" in *Managing the risk of workplace stress: Health and safety hazards*: Routledge Taylor & Francis Group, London, UK, pp. 5-18
5. Clarke, C. and Cooper, C. L. (2004), "Human Factors", In *Managing the risk of workplace stress: Health and safety hazards*: Routledge Taylor & Francis Group, London, UK, pp. 61.
6. Clarke, C. and Cooper, C. L. (2004), "Organization and management, Safety management practices, Safety culture, Safety climate, Leadership," in *Managing the risk of workplace stress: Health and safety hazards*: Routledge Taylor & Francis Group, London, UK, pp. 32-56.
7. Dietrich, A. and Pigeyre, F. (2005), "Strategic choices and social legitimacy," in *Human Resources Management*, 1st ed. Paris, France: La Découverte, ch 6, pp. 105-109
8. Djellal, F. and Gallouj, F. (2008), "PRODUCTIVITY: DETERMINANTS AND STRATEGIES, The traditional factors influencing productivity," in *Measuring and improving productivity in services: Issues, strategies and challenges*: Edward Elgar Publishing, Cheltenham, UK, Northampton, MA, USA, pp. 121-142
9. Garibaldi, P., Martins, J. O. and Ours, J. V. (2011), "The impact of Health on Productivity and Growth, Health, Human Capital, and Growth: General results," in *Ageing, Health, and Productivity: The Economics of Increased Life Expectancy*: Oxford University Press, City, Country, pp. 73.
10. Han Li, Mei Qiang, Lu Yu-mei etc., (2004), Analysis and Study on AHP-the Fuzzy Comprehensive Evaluation Method, China Journal of Safety Science 14(7), pp. 86.
11. Helfer, J. P., Kalika, M. and Orsoni, J. (2010), "Strategic change," in *Management, Strategy and Organization*, 8th ed. Paris,

France: Magnard-Vuilbert, ch. 8, sec. 1, pp. 393–404

12. Mazur, A. (2015), "Model of OHS Management Systems in an Excellent Company," In *Antona M., Stephanidis C. (eds) Universal Access in Human-Computer Interaction. Access to the Human Environment and Culture*. UAHCI 2015. Lecture Notes in Computer Science, vol 9178: Springer, Cham. Aug. DOI: 10.1007/978-3-319-20687-5_44

13. Oswald, A. J., Proto, E. and Sgroi, D. (2012), "Happiness and Productivity," [Online]. *JOLE*, vol. 33, n. 3, pp. 4-10, 10th Feb. 2014, .[Retrieved July 3, 2016]. <https://doi.org/10.1086/681096>

14. Purcell, J., Kinnie, N., Swart, J., Rayton, B. and Hutchinson, S. (2008), "Culture and Values" in *People management and performance*: Routledge Taylor & Francis Group, Thames, Oxfordshire UK, Jul., pp. 19-41

15. Purcell, J., Kinnie, N., Swart, J., Rayton, B. and Hutchinson, S. (2008), "Understanding the link between people management and organisational performance" in *People management and performance*: Routledge Taylor & Francis Group, pp. 1-18

16. Qiu Wan-hua, Liu Bei-shang and Hou Lin-lin, (2008), REM Assembly Based on the

Reliability of Entropy, *Systems Engineering* 26(5), pp. 80-84.

17. Spreitzer, G. and Porath, C. (2012), "Creating sustainable performance," : Harvard Business Review.

18. Summerhayes, S. D. (2010), "Construction-related health and safety legislation," in *Design Risk Management: Contribution to Health and Safety*: Wiley Blackwell, Oxford, UK, pp. 39-40.

19. Székely, F. (2005), "Responsible Leadership and Corporate Social Responsibility: Metrics for Sustainable Performance," in *European Management Journal*, [Online]. Volume 23, Issue 6, Dec. 2005, pp. 628-647. [Retrieved June 15, 2017]. <https://doi.org/10.1016/j.emj.2005.10.009>

20. Wang Jian and Xu Ya-bo, (2005), "Application of Fuzzy Mathematics," in *Safety Evaluation, Theory and Research* 2, pp. 29.

21. Zhang Jun, Yang Wei-ping, Yang Li-gong etc., (2011), "Application of Fuzzy Comprehensive Evaluation," in *Open-pit Mine Safety Assessment*, *Journal of Safety and Environment* 6, pp. 259.

22. Zhao Guang-jin, (2012), Research on Mine Enterprise's Safety Management Based on Entropy Theory, *China Journal of Safety science* 22(3), p. 73.