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Helping Safety Managers Make Project Decisions in the Workplace: Weighted Scoring Decision Making

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Abstract

Safety professionals must routinely make effective decisions based on available information. This paper describes the weighted scoring decision making (WSDM) method, and includes a case study at a manufacturing plant to demonstrate how the technique provides an analytical evaluation of several computerized occupational health and safety (OHS) information management systems. First, the weighted selection criteria were identified along with their merit factor levels and scores. Each candidate information management system program was then evaluated based on the selection criteria provided by the safety engineer and occupational health nurse (OHN) of the organization. The authors discuss the development of a spreadsheet application of the WSDM method to assist the safety manager/engineer in evaluating and selecting from numerous candidate management systems.

Introduction

Safety professionals routinely face responsibilities and challenges to reach a satisfactory level of certainty in a dynamic workplace. One of the main responsibilities, and most difficult challenges for safety professionals, lies in making safe, effective, and sometimes quick decisions based on available information. Effective recommendations and decisions made by safety professionals not only help establish, promote, and maintain a safe environment for all employees, but also contribute to keep their organizations success in a competitive market. Successful safety managers integrate information, their experience, and proven techniques to provide a systematic framework for their decision making. This process must be able to predict potential undesirable outcomes of their decisions. Safety literature provides a variety of decision methods and their applications. Roland and Moriarity (1990) discussed several methods including the Delphi method, committee decision method, metric matrix hierarchical analysis, game theory, payoff matrix reduction, minimax-maxmini decision criteria, regret decision criteria, and multi-attribute decision making. Gentile, Rogers, and Mannan (2003) developed a fuzzy logic-based

measurement of inherent safety (index) to help model uncertainty and subjectivities inherent in evaluating data with quantitative and qualitative variables.

Weighted Scoring Decision Making (WSDM) Method

One of the fundamental, effective, and technical tools available for decision making processes is the WSDM method. This method provides a disciplined subjective approach for considering multiple criteria when selecting a rationally favored choice from a field of candidate choices (Clemens, 2002). The approach is applicable to any physical project (simple components, products, machines, processes) or management system (information systems, computer applications, system designs, analytical approaches). The WSDM has been used to evaluate commercial off-the-shelf software selection (Kontio, 1996). In the chemical process industry, the method has been implemented to identify the most desirable chemical process option (Hendershot, 1996). For safety applications, the method can be implemented when evaluating many issues (e.g., safety solutions, PPE, and training modules).

Essentially, when faced with a decision involving several potential solutions, each favoring different selection criteria (cost, downtime, compatibility, ease of implementation, etc…), a tool such as WSDM allows the safety manager the opportunity to objectively compare these potential solutions against each other, and choose a favored candidate based on the selection criteria and weighting preferences.

The WSDM method is the result of integrating the four major steps described below:

1. Identify selection criteria.
   A team of safety professionals and/or other experts in the workplace can help safety managers identify selection criteria appropriate to making the decision at hand. In order to utilize the method efficiently, it is recommended to have between 3 and 10 selection criteria.

2. Weight the selection criteria.
   Arbitrary selected, dimensionless values are assigned to each criterion. This is perhaps the most critical and subjective step in the method. Safety managers, with the help of their safety teams, should select an “importance value or weight” for each selection criterion according to its judged worth. The values reflect the importance each criterion plays in forming the decision. The sum of these weights should add up to 10, 100, 1000, etc. However, it is recommended to use a 100-point scale to provide enough distinction between the results and simplify the interpretation of the results.

3. Assign criteria merit factor levels and scores.
   The next step is to define mutually exclusive merit factor levels, and assign their corresponding discrete-step, dimensionless merit factor scores within each selection criterion. The number of merit factor levels is a function of the complexity and importance of each selection criterion. Some criteria may have as low as two (2) levels, others may have many. Merit factor scores should range between 0 and 1 to reflect a proportional weight of its selection criterion. This assignment process is illustrated in Table 1.

4. Evaluate criteria for each candidate.

The final step in applying the WSDM approach is to score each candidate based on its fit to a merit factor level in each selection criterion. The sum of such fits for all selection criteria provides the user with a score or percentage. The candidate with the highest score is picked for the decision at hand. The American Institute of Chemical Engineers provides additional information about the WSDM and its applications (Center for Chemical Process Safety, 1995).

Case Study

During an interdisciplinary course at one of the NIOSH supported Education and Research Centers (Taylor, Muhdi & Brooks, 2006), a local manufacturing facility approached the Center to help research, and provide systematic recommendations for evaluation of computerized OHS information management system programs. Initially, the evaluation specifically addressed the OHS information management needs of a single manufacturing facility in the Southeast.

A team of three graduate students (OS&E, IH, OHN) and their faculty advisor, worked with the facility occupational health nurse (OHN) and site safety engineer during the course of the project. Most of the OHS data and records were stored in hardcopy format at the facility, or in Excel spreadsheets on individual computers. The issues identified by the OHN and safety engineer under their existing system of OHS information management included:

- Paper overload and lack of storage.
- Ineffective ability to collect, aggregate, organize, move, and represent information in an economical, efficient way that is beneficial to users.
- Lack of ability to transform data into information, and information into knowledge.
- Increase in health-related legislation with requirements for extensive record keeping, reporting, and documentation (confidentiality and HIPPA compliance).
- Need to operate occupational health services as a “business”.
- Lack of coordination of computer services/programs that would be useful for both occupational health and safety services.

The team felt that the use of an effective *computerized OHS information management system program* should eliminate most of these issues, and that the WSDM method could be a tool for selecting an appropriate program.

Methods

The work site evaluation team met with the OHN and safety engineer to discuss the requirements and capabilities for the OHS information management system program. The following list identifies the desired capabilities of the OHS program, as outlined by the OHN and safety engineer.

- Development and management of budget-line items.

- Develop and implement protocols and standards of practice (clinical) that ensure consistent delivery of goal-orientated services.
- Develop and implement policies that protect the health of employees.
- Produce reports that help business leaders make decisions.
- Pre-placement medical evaluations.
- On-the-job injury treatment documentation.
- Clinic visit notes and immunization records.
- Work restriction and disability case management records.
- Participation in workplace surveillance programs.
- Assignment and fitting of PPE.
- Examination and test results (e.g. vision, fit testing, audiograms).
- Industrial hygiene sampling activities/results, and exposure documentation.
- OSHA record keeping.
- Equipment calibration and record keeping.

The team then researched and evaluated a variety of computerized programs and summarized the results including costs, technical support, and concerns. After meeting with the manufacturer, each team member began researching the potential OHS programs. A final list of potential OHS programs was developed based on team members researching the internet for available OHS programs, and recommendations from the manufacturer.

The team identified the following potential OHS information management system program candidates:

- Candidate (A) can be web-based, client server or application service provider (ASP) based. The estimated price for the package, installation, training, and 25 modules is $54,350 for one concurrent user. Candidate A is totally customizable, that is to say fields within each module can be modified by the client and the modules' interfaces can be changed by the client to fit their needs. This program was judged "moderate to navigate" by team members.

- Candidate (B) can be web-based or ASP based. The estimated price for the package, training and extra modules is $37,800 for the web-based package and $19,156 for the ASP package. This program was judged "easy to navigate."

- Candidate (C) can be web-based or client server based. The estimated pricing for the package, custom reports, training and extra modules is $23,500. This program was judged "easy to navigate."

- Candidate (D) can be installed on a single computer or client server based. The estimated price for the package, training and all seven modules is $37,800 for the client server based package. Candidate D appears to be more useful to a medical organization, as opposed to an industrial facility.

- Candidate (E) can be installed on a single computer or client server based. The estimated price for the package, training and all seven modules is $26,165 for the client server

based package. The estimated training time is for two days. This program was judged "easy to navigate."

- Candidate (F) can be web-based or ASP based. The estimated pricing for the training, three core modules (application administration, employee management, and reports & indicators), four health/medical management modules, two safety management modules and an on-site business process analysis is $360,000. Candidate F is a very robust system that is typically used by large companies and governmental organizations. This program was judged "difficult to navigate".

The research team implemented the WSDM approach to evaluate each of the candidate programs. After discussions with the OHN and safety engineer, the weighted selection criteria were identified along with their merit factor levels and scores. Table 1 lists the selection criteria, their weights and merit factor levels for this project.

CRITERION (Weight)	EVALUATION (Merit Factor Levels for each Criterion)	MERIT FACTOR
C-1 Compatibility (35)	I - Full compatibility (security & confidentiality, departments, facilities, # users at the same time, network requirement, # modules, software performance)	1.0
	II - Partial compatibility (security & confidentiality, # users at the same time, network requirement, # modules, software performance)	0.7
	III - Limited compatibility (security & confidentiality, # users at the same time)	0.5
C-2 User Friendly (30)	I - Easy to navigate	1.0
	II - Moderate to navigate	0.5
	III - Difficult to navigate	0.0
C-3 Technical Support (20)	I - 24x7 online-person	1.0
	II - 24x7 automated support	0.8
	III - 24x7 by phone support	0.6
	IV- Software manual and built-in help menu	0.3
	V- Regular on site visits	0.0
C-4 Service Options (10)	I - Full service (updates, notify customers with issues & problems, language options, customized modules, interaction with other systems, backup)	1.0
	II - Partial service (updates, notify customers with issues & problems, interaction with other systems, backup)	0.7
	III - Limited service (updates, notify customers with issues & problems, backup)	0.5
	IV - Restricted service (updates, backup)	0.3
C-5 Cost (5)	I - < $5,000	1.0
	II - $5,000 to $10,000	0.8
	III - $10,000 to $15,000	0.6
	IV- $15,000 to $20,000	0.4
	V - > $20,000	0.2

Table 1: Selection criteria (C:1-5), weights (5-35), merit factor levels (0.0-1.0) for OHS information management system programs.

The research team then evaluated each information management system program based on the selection criteria provided by the manufacturer. The team also developed a spreadsheet application to assist in evaluating and selecting the candidate software packages. Table 2 illustrates the spreadsheet application for this project with a sample candidate.

CANDIDATE:	Candidate F

CRITERION	MERIT FACTOR LEVEL	MERIT FACTOR	WEIGHTED SCORE
COMPATABILITY	Full compatibility	1.0	35.0
USER FRIENDLY	Difficult to navigate	0.0	0.0
TECHNICAL SUPPORT	24x7 automated support	0.8	16.0
SERVICE OPTIONS	Full service	1.0	10.0
COST	> $20,000	0.0	0.0

FINAL SCORE	61.0%

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Table 2: Sample spreadsheet application for the OHS information management system programs.

Discussion

Most of the reviewed OHS information management system programs were capable of meeting the manufacturer's requirements. However the differences between these programs were notable in factors such as cost, technical support, service options, and ease of navigation. During this project only the manufacturer's single facility's needs were considered, however an effective OHS information system program might be potentially expanded corporation wide. Thus the ability of the candidate OHS program to service multiple concurrent users and multiple facilities might be an additional consideration. With this in mind, the Web- or ASP-based programs would be a better choice than client server-based, but the expansion of users or facilities does potentially incur additional costs. All the OHS packages were >$20,000, thus the cost criterion was underestimated by the team and the manufacturer in their initial round of the WSDM method. This suggests that the cost merit factor levels should be reset to include the range of price options. Finally, the WSDM tool could be modified to reflect changes or additions in criteria for further delineation of differences in the OHS management system programs. Based on the WSDM approach, the various candidates scored:

1. Candidate C (WSDM= 88.0%): The final recommendation for the project.
2. Candidate B (WSDM= 84.0%).
3. Candidate E (WSDM= 80.5%).
4. Candidate A (WSDM= 72.0%).
5. Candidate D (WSDM= 66.5%).
6. Candidate F (WSDM= 61.0%).

Conclusions and Recommendations

The WSDM method has been applied for the evaluation of several computerized occupational safety and health information management systems for a local manufacturer. The method has provided the professionals at the manufacturing facility with an analytical evaluation of candidate information system programs.

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