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Field Report

Employee Impact and Attitude Analysis for GHS Implementation in Taiwan

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Abstract: The employee impact and attitude analysis for GHS implementation in Taiwan was investigated in this study. An impact assessment on the new regulations or changes in regulations for government, potential costs, benefits, and the global trade in chemicals to industries and hazard communication program for workers was studied by the methods of the questionnaire design and Delphi expert method. A survey was conducted using questionnaires and taking 200 experts from government's expert database and 500 selected respondents from case company. Results from present study revealed that the barrier associated with GHS implementation is existed; it is feasible to overcome. Both experts and employees think that business entities are insufficient to test and classify chemicals on their own, and the technical guidance from the government is needed. Data analyzed by the logistic regression revealed that more hours an employee spends on education and trainings of new GHS systems; the employee thinks implementation of GHS will improve hazard awareness for transporters. The weak labeling ability affects deployment of the new GHS system.

Key words: Globally Harmonized System (GHS), Impact assessment, Delphi expert method

Introduction

Currently, a great number of chemicals are heavily used by different industries in the world, and their types have been growing exponentially. While global trade is intensified, the classification and labeling systems as well as regulations of chemical substances are inconsistent in different countries[1–5]. Therefore, integrating chemical data and unifying chemical classification and labeling systems have emerged to become an important goal in the international community, as this can both substantially eliminate environmental and health hazards and effectively reduce associated mistakes made in global trades.

GHS, or Globally Harmonized System for Classification and Labeling of Chemicals, an important basis for the safe use of chemicals in the world, is thus conceived to set a worldwide standard for chemical classification, labeling and standardized material safety data sheets. The UN Purple Book has completed classification of 27 hazardous chemicals and format designs for labeling and material safety data sheets to address issues facing the international community when implementing the GHS system. The Taiwan Government has already commissioned the Council of Labor Affairs to construct an online database to provide classification details of pure chemicals, labeling specifications and material safety data sheets. About 3,000 types of chemicals have been included in the database, and this number now is equivalent to the amount of records stored

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in the Japan database as of August 2006[6–17].

The Council of Labor Affairs (CLA), Executive Yuan, published the Regulation of Labeling and Hazard Communication of Dangerous and Harmful Materials on December 19, 2007 for GHS at workplaces. CLA then referred to standards adopted in developed countries (such as Japan) to implement GHS in phases and announced two days later that GHS will apply to all dangerous and harmful materials listed in the 12/19/2007 notice after December 31, 2008. Research results from Su and Hsu (2008) indicated that the college students' perception to traffic signs is 1.7 times higher than that of chemical substance labels, and suggested that training on chemical labeling should be integrated into the school curriculum[18]. Su *et al.* (2009) provided basic information regarding GHS implementation and the requirements[19]. There are few researches regarding the test method and national implementation of GHS[20–22], however, the study on the impact of GHS implementation is rather anemic. Thus, the purpose of present work is to thoroughly analyze influences that GHS implementation will generate on industries and their employees.

Implementing the Strategic Approach to International Chemicals Management (SAICM) can reduce risks facing employees. Yet, changing our existing hazard and labeling systems and directly adopting the new GHS system may generate impacts of different levels on industries and their employees. This will require a consensus analysis, importance and feasibility interpretations to overcome barriers encountered during GHS implementation. The purposes and key areas to explore in present work include:

1. Indicator weight assessment of impacts, generated in GHS implementation, on industries in Taiwan from the perspectives of scholars and industrial experts
2. Attitude analysis on importance and feasibility indicators of GHS implementation from the employee perspectives
3. Comparative analysis on the impact heterogeneity from both expert and employee perspectives
4. Providing recommendations of GHS implementation for the government and industries.

And two hypotheses are proposed in this study,

The hypothesis 1: The implementation of GHS in Taiwan was started since December 31st, 2008. The employer and employee have the executive ability about GHS implementation.

The hypothesis 2: There is no difference for the GHS perception between the experts and employees.

Methods

Expert survey

In present study, the expert survey was conducted by screening for scholars and specialists with GHS backgrounds from the expert database (containing 743 records) of Institute of Occupational Safety and Health, Council of Labor Affairs Executive Yuan. A total of 200 respondents (100 scholars and 100 industrial experts) were purposively sampled to conduct the subsequent questionnaire and consensus analysis using the Delphi method. The questionnaire was mailed to 200 experts for reviewing, and 127 valid questionnaires were collected. For the second questionnaire, the questionnaire review team revised some of the questions based on the results of the first questionnaire collected. The questionnaire was modified subsequently in order to ensure the correctness and validity of the survey. Several rounds of questionnaires are sent out, and the anonymous responses are collected and shared with the group after each round. The experts are allowed to adjust their answers in subsequent rounds. Because multiple rounds of questions are asked and because each member of the panel is told what the group thinks as a whole, the Delphi method seeks to reach the "correct" response through consensus[23].

Contents of the questionnaire were divided into three major parts: (1) six questions regarding the personal data of the experts including education, professional specialty, occupation, seniority, whether or not the respondents had ever received training courses in hazard communication, as well as whether or not the respondents had ever received training courses in GHS; (2) Twenty-one questions regarding the influences of GHS implementation, among them, twelve items are for positive influence analysis and nine items are for negative influence analysis (please refer to Table 2 of the detail); (3) Forty-six questions regarding the importance and feasibility influence analysis of expert and employee perception on GHS implementation (please refer to Table 3 and Table 4 of the detail). Likert-type scale of 1–5 with 5 denoting "strongly agree" was used for measurement.

Chemical impact cognitive research on case company

Many chemical companies were classified as the small and medium companies in Taiwan; they need the import that must face the difficult situations of investigation. Aviation industry has the higher scope of department, and many kinds of chemicals are used in numerous manufacturing processes. The staff has the regular education degree. Higher coordination degree also was considered for this study. Thus, in this work, the case company (belongs to aviation industry) with 1,500 employees was chosen for study. A total of 500 respondents were sampled, and they were surveyed using questionnaires based on their types of jobs and positions (Types of jobs: 150 respondents from the production division, 150 respondents from the maintenance division, and 200 respondents from the Environment, Safety and Health (ESH) division; positions: management, mid-levels, and first line workers).

After invalid questionnaires were eliminated, the number of valid questionnaires was 371. A quadratic equation, developed using dependent variables from the logistic regression analysis, was constructed to conduct the cognitive research regarding whether there is an impact of chemicals; and as for assessments on the factors influencing cognitions of the respondents, a logistic regression model was constructed[24]. The purpose of this research model is to identify main contributing factors influencing implementation of chemical management systems, and so, the improvement policies and countermeasures can be conceived to reduce risks associated with chemical hazards and improve sustainable operations and competitiveness of enterprises.

Data and statistical analysis

In questionnaire consensus analysis, the quartile deviation (QD) was applied in this work. The QD is half the difference between the upper and lower quartiles in a distribution. If there is any one subject's QD value smaller than or is equal to 0.6, it mean that which is achieve high consensus. The moderate consensus is QD=0.6–1. The lower consensus is QD>1. The experts reached consensus on the second questionnaire, so there is no need for the third questionnaire.

Results from the returned questionnaires were analyzed using the Statistical Package for the Social Sciences, SPSS for Windows 11.5 (SPSS Inc., Chicago, Illinois) program. Descriptive statistics was used for background information of the respondents. The Student's *t*-test was used to correlate the relationships between the perception and background items, such as influences of GHS implementation and the importance and feasibility indicators of GHS implementation. The reliability of the designed questionnaires regarding the influences of GHS implementation (21 questions), the importance indicators of GHS implementation (46 questions) and the importance and feasibility indicators of GHS implementation (46 questions) were calculated by Cronbach's α coefficient. The Cronbach's α is a measure of internal consistency, and a high value of α is often used as evidence of reliability.

In the influence analyses of expert and employee perception on GHS implementation, the effect-size used as a standardized index which is independent of sample size and quantifies the magnitude of the difference between populations. In this work, the effect size for differences in means is apply to Cohen's d, which is defined in terms of means and the root mean square standard deviation (SD), as shown below.

$$d = \frac{\left|\text{mean}_1 - \text{mean}_2\right|}{\sqrt{\frac{\left(SD_1^2 + SD_2^2\right)}{2}}} \tag{1}$$

The Cohen's d value 0.2, 0.5 and 0.8 is listed as suggested values for low, medium and high effects (Cohen, 1988)[25].

Furthermore, a logistic model was used to analyze the importance of each factor that affects the results of perception as below:

$$\ln\left(\frac{p}{1-p}\right) = B_0 + B_1X_1 + B_2X_2 + \ldots + B_kX_k \tag{2}$$

The dependent variable, a dichotomous type, in the above model is the person whose correct answer percentage for those GHS problems is higher or lower than the average. *p* is the probability of having better perception as defined above at the conditions of Xi, which are the independent variables having influences on the results of perception. Only three possible influential factors are selected for regression to avoid unexplainable results, the influential factors are X1: Years of experience at the current position; X2: Hours spent on previous version of general education and trainings on hazards; X3: Hours spent on education and trainings of new GHS systems. Bi are the coefficients calculated by logistic regression. Larger Bi denote larger weighting value, i.e. the factor is more important. Positive Bi denotes positive relationship between the dependent and independent variables and vise versa.

Moreover, an odds ratio is used to compare the odds for two groups. It is calculated by dividing the odds in group 1 by the odds in group 2. When the odds ratio is greater than one, indeed the 95% confidence interval for the odds ratio is not include an odds ratio of one, thus it could be concluded that odds ratio had significantly different levels.

Table 1. Validity analysis

Variable	Number of items	Cronbach α	Degree of validity
Positive and negative influence of GHS implementation	21	0.930	High
importance indicators of GHS implementation	46	0.965	High
Feasibility indicators of GHS implementation	46	0.950	High

Results

Reliability and validity analysis

Cronbach α is utilized in this study to evaluate the consistency and stability for the validity of this study. For the 21 items measuring influences of GHS implementation and 92 items investigating the importance and feasibility indicators of GHS implementation (46 items for importance and 46 items for feasibility), Cronbach α is 0.930, 0.965, 0.950, respectively. As pointed out by Nunnally that Cronbach α needs to be greater than 0.70[26], the validity of this study is very high, as shown in Table 1.

Questionnaire recovery

In expert survey, 200 questionnaires were sent to respondents by postal mail and 127 questionnaires were returned experts, giving a recovery rate of 63.5%.

In the case company, a total of 500 respondents were sampled. After invalid questionnaires were eliminated, the number of valid questionnaires is 371, giving a response rate of 74.2%. Estimating the employee perception under a 95% confidence interval, then the sampling error rate is 4%. As for the employee perception on the national level, the sampling error size is estimated to be 1.96, and error rate was 5%. Judging from acceptable margin of error for questionnaires adopted in the field of social statistics (1–5%), the margin of error is acceptable for this study[27, 28].

Consensus analysis for importance and feasibility indicators for GHS implementation

(1) Expert viewpoints on implementing GHS − importance: Among all 46 items, one item reads an ultra high degree of consensus (QD=0 − the 2nd item, implement GHS on mixtures with the estimation technique,) 42 items read a high degree of consensus, and the remaining three items read a fair degree of consensus, indicating that surveyed experts have a high degree of consensus on importance of GHS implementation.

(2) Expert viewpoints on implementing GHS − feasibility: Among all 46 items, one item reads an ultra high degree of consensus (QD=0 − the 11th item, implement GHS on users of chemicals,) 36 items read a high degree of consensus, and the remaining nine items read a fair degree of consensus, indicating that surveyed experts have a high degree of consensus on feasibility of GHS implementation.

Attitude analysis on indicator weight of ghs implementation

(1) Positive and Negative Influence on GHS Implementation

(a) Positive influence analysis of expert and employee perception on GHS implementation points out that:

As shown in Table 2, 8 positive influence items are statistically significant as $p<0.001$, which including: reduce occupational injury, reduce hazards of chemicals, increase hazard awareness for all employees, increase hazard awareness for transporters, increase hazard awareness for consumers, improve corporate image, improve health and safety protection for employees, improve eco-environmental quality. Among them, 2 items' (reduce hazards of chemicals, improve corporate image) Cohen's d values are between 0.2–0.5, the else's are between 0.5–0.8.

(b) Negative influence analysis of expert and employee perception on GHS implementation points out that:

$p<0.001$: insufficient funds for classification and labeling, influences of chemical registration (EU Reach) on product competitiveness. And both the two items' Cohen's d values are between 0.2–0.5.

(2) Influence of Importance Indicator of GHS Implementation

Importance influence analysis of expert and employee perception on GHS implementation points out that:

As shown in Table 3, there are a total of 46 issues gauging the heterogeneity among importance indicators of GHS implementation, and 11 of which have achieved statistical significance. Among the 11 issues, the most 4 important indicators of GHS implementation ($p<0.001$) are: business entities to test and classify by themselves, implement GHS for ordinary consumers, implement GHS for construction industry, implement GHS for service industry. The Cohen's d values between 0.2–0.5 are the indicators of implement GHS for ordinary consumers, implement GHS for service industry. The Cohen's d values between 0.5–0.8 are the indicators of business entities to test and classify

Table 2. The *t*-test for the positive and negative influence analysis of expert and employee perception on GHS implementation

Item	Indicator	Export n1=127		Employee n2=371		*t*	*p*	Cohen's d
		Average	SD	Average	SD			
Positive influence on GHS implementation								
1	Reduce occupational injury	3.59	1.01	4.20	0.87	6.026***	0.000	0.65
2	Reduce hazards of chemicals	3.73	1.07	4.20	0.82	4.481***	0.000	0.49
3	Increase hazard awareness for all employees	3.54	1.01	4.15	0.88	6.039***	0.000	0.64
4	Increase hazard awareness for transporters	3.46	1.08	4.15	0.90	6.468***	0.000	0.69
5	Increase hazard awareness for consumers	3.24	1.13	4.00	0.95	6.714***	0.000	0.73
6	Increase hazard awareness for ESH personnel	3.94	1.92	4.20	0.84	1.416	0.159	0.18
7	Improve government image	3.90	0.97	4.07	0.95	1.749	0.081	0.18
8	Improve corporate image	3.66	1.05	4.11	0.92	4.291***	0.000	0.46
9	Improve international competitiveness	3.97	0.95	4.12	0.93	1.615	0.107	0.16
10	Improve health and safety protection for employees	3.67	1.09	4.23	0.84	5.237***	0.000	0.58
11	Improve eco-environmental quality	3.56	1.12	4.25	0.87	6.311***	0.000	0.69
12	Influences of chemical registration (EU Reach) on product competitiveness	3.93	1.03	4.18	0.90	2.601**	0.010	0.26
Negative Influence on GHS implementation								
1	Weak classification ability	4.15	0.77	4.14	0.89	–0.098	0.922	0.01
2	Weak labeling ability	4.14	0.83	4.13	0.86	–0.102	0.919	0.01
3	Insufficient funds for Classification and labeling	3.85	0.90	4.17	0.84	3.653***	0.000	0.37
4	Not enough dedicated specialists	4.05	0.87	4.14	0.84	1.036	0.301	0.11
5	Lack of time to adapt	3.89	0.90	4.03	0.90	1.511	0.132	0.16
6	Insufficient funds for Relevant trainings and education	3.84	0.88	4.13	0.85	3.172**	0.002	0.34
7	Incomplete regulation	4.09	0.92	4.21	0.84	1.435	0.152	0.14
8	Difficult to acquire relevant information	4.19	0.82	4.17	0.83	–0.244	0.807	0.02
9	Influences of chemical registration (EU Reach) on product competitiveness	3.74	0.96	4.07	0.94	3.318***	0.001	0.35

*statistically significant *$p<0.05$ **$p<0.01$ ***$p<0.001$.

by themselves, implement GHS for construction industry.

(3) Influence of Feasibility Indicator of GHS Implementation

As shown in Table 4, there are a total of 46 issues gauging the heterogeneity among feasibility indicators of GHS implementation, and 27 of which have achieved statistical significance. Among the 27 issues, the most 11 statistically significant indicators ($p<0.001$) are: test chemical to implement GHS, implement GHS on mixture with estimation techniques, business entities to test and classify by themselves, implement GHS for ordinary consumers, implement GHS for construction industry, implement GHS for service industry, industry to conduct GHS test and classification on mixtures, Taiwan to implement chemical registration, declaration and control (EU Reach system), enforce standardized regulations to manage hazardous materials according to GHS, add GHS into type 1–9 labels and healthy, ecological, and warning labels according to GHS and existing transportation symbols, effectively and interdepartmentally integrate GHS related regulations. Among upon 11 ($p<0.001$) statistically significant indicators of GHS implementation, there are 5 indicators located in the Cohen's d values between 0.2–0.5, 4 indicators are between 0.5–0.8, and 2 indicators (business entities to test and classify by themselves, implement GHS for construction industry) are higher than 0.8. Experts and employees both rate lower on business entities to test and classify by themselves, as they both think that business entities are insufficient to test on their own.

(4) Logistic Regression Analysis on Positive and Negative Influence on GHS Implementation of Case Company

(a) In this logistic regression model, three independent variables (X_1, X_2, X_3) are adopted to predict the dependent variable, influence of GHS implementation on improvement of hazard awareness for transporters (1: influence does exist; 0: influence does not exist). From the results of positive influence of GHS implementation on improving hazard awareness for transporters (Table 5), B_1 is −0.124 for X_1, indicating the longer an employee stays at a job, the less likely that employee will think GHS implementa-

Table 3. The *t*-test for importance influence analysis of expert and employee perception on GHS implementation

Item	Issue	Export n1=127		Employee n2=371		*t*	*p*	Cohen's d
		Average	SD	Average	SD			
Importance indicator of GHS implementation								
1	GHS test chemical to implement GHS	3.99	0.81	4.08	0.75	1.091	0.276	0.12
2	Implement GHS on mixture with estimation techniques	3.93	0.70	4.04	0.76	1.449	0.148	0.15
3	Business entities to test and classify by themselves	3.35	0.86	3.83	0.91	5.183***	0.000	0.54
4	Business entity to outsource chemical classification	3.68	0.76	3.84	0.94	1.888	0.060	0.19
5	Government to commission non-profit organizations for conducting testing and classifications	4.20	0.75	4.15	0.71	–0.706	0.481	0.07
6	Implement GHS for employees	4.12	0.79	4.21	0.70	1.289	0.198	0.12
7	Implement GHS for transporters	4.28	0.72	4.22	0.76	–0.827	0.409	0.08
8	Implement GHS for emergency responders	4.17	0.72	4.25	0.77	0.940	0.348	0.11
9	Implement GHS for chemical suppliers	4.40	0.71	4.30	0.76	–1.368	0.172	0.14
10	Implement GHS for chemical manufacturers	4.41	0.70	4.31	0.74	–1.359	0.175	0.14
11	Implement GHS for chemical users	4.21	0.72	4.25	0.73	0.452	0.651	0.06
12	Implement GHS for ordinary consumers	3.68	0.80	4.02	0.83	3.968***	0.000	0.42
13	Implement GHS for manufacturing industry	4.32	0.70	4.19	0.75	–1.745	0.082	0.18
14	Implement GHS for construction industry	3.64	0.84	4.15	0.74	6.071***	0.000	0.64
15	Implement GHS for service industry	3.58	0.85	3.99	0.89	4.447***	0.000	0.47
16	Taiwan to implement GHS with other countries	4.51	0.57	4.21	0.74	–0.743	0.459	0.45
17	Establish MSDS according to GHS	4.35	0.73	4.22	0.72	–1.784	0.075	0.18
18	Industry to establish MSDS according to GHS	4.31	0.71	4.14	0.82	–2.085*	0.038	0.22
19	Government to establish MSDS for GHS	4.38	0.70	4.22	0.78	–2.067*	0.039	0.22
20	Industry to establish labeling system according to GHS	4.27	0.69	4.10	0.81	–2.103*	0.036	0.23
21	Government to establish labeling system according to GHS	4.24	0.80	4.24	0.74	–0.115	0.908	0.00
22	Industry to establish hazardous chemicals control database for GHS	4.24	0.76	4.12	0.82	–1.406	0.160	0.15
23	Government to establish hazardous chemicals control database for GHS	4.39	0.73	4.21	0.75	–2.365*	0.018	0.24
24	Industry to conduct GHS test and classification on mixtures	3.98	0.89	3.98	0.90	–0.034	0.973	0.00
25	Government to conduct GHS test and classification for mixtures	4.17	0.81	4.20	0.77	0.434	0.664	0.04
26	Industry to conduct GHS test and classification for new chemicals	4.15	0.76	3.99	0.91	–1.775	0.076	0.19
27	Government to conduct GHS test and classification for new chemicals	4.28	0.76	4.20	0.79	–0.957	0.339	0.10
28	Establish effective training systems for employees according to GHS	4.34	0.64	4.28	0.75	–0.756	0.450	0.09
29	Schools to implement labor safety and health education and training according to GHS	4.20	0.76	4.25	0.80	0.643	0.521	0.06
30	Taiwan to implement chemical registration, declaration and control (EU Reach system)	4.19	0.74	4.24	0.79	0.676	0.499	0.07
31	Seamlessly connect GHS to REACH	4.11	0.75	4.17	0.73	0.821	0.412	0.08
32	Enforce standardized regulations to manage hazardous materials according to GHS	4.16	0.81	4.15	0.72	–0.070**	0.944	0.01
33	Add GHS into type 1–9 labels and healthy, ecological, and warning labels according to GHS and existing transportation symbols	4.08	0.82	4.19	0.73	1.451	0.147	0.14
34	Uniformly regulate the transportation symbols on appearance of transported materials and contents and GHS	4.25	0.74	4.19	0.73	–0.825	0.409	0.08
35	GHS adopt train the trainer approach for GHS implementation	4.08	0.68	4.16	0.76	1.179*	0.240	0.11
36	GHS adopt e-learning approach to implement GHS	3.91	0.73	3.92	0.90	0.072**	0.943	0.01
37	Effectively and interdepartmentally integrate GHS related regulations	4.33	0.73	4.20	0.78	–1.583	0.114	0.17
38	Set up trade secret protections for chemical labels	4.05	0.79	4.04	0.82	–0.081	0.935	0.01
39	GHS implementation requires regulatory enforcement from government	4.16	0.78	4.18	0.75	0.233	0.816	0.03
40	Government to provide technical guidance on GHS implementation for SME	4.28	0.70	4.20	0.75	–0.962	0.336	0.11
41	Government to provide technical guidance on GHS implementation for large enterprise	4.13	0.73	4.16	0.75	0.292	0.770	0.04
42	Urge industry to gradually establish standard to control GHS specified hazardous chemicals	4.24	0.67	4.18	0.76	–0.731	0.465	0.08
43	Promote implementation buffer period of consumer labeling system	3.96	0.81	4.05	0.82	1.110	0.268	0.11
44	Integrate the EU REACH system into the enabling statute of Labor Safety and Health Act, and risk assessment reports covering the manufacturing and importing processes should be submitted to the relevant government authorities.	3.98	0.76	4.16	0.76	2.233	0.026	0.24
45	Promote GHS system through public media	4.19	0.79	4.19	0.76	0.064	0.949	0.00
46	Promote GHS system through the school system	4.20	0.72	4.19	0.78	–0.035	0.972	0.01

*statistically significant *p<0.05 **p<0.01 ***p<0.001.

Table 4. The *t*–test for feasibility influence analysis of expert and employee perception on GHS implementation

Item	issue	Expert n1=127		Employee n2=371		*t*	*p*	Cohen's d
		Average	SD	Average	SD			
Feasibility indicator of GHS implementation								
1	GHS test chemical to implement GHS	3.55	0.80	4.04	0.75	6.008***	0.000	0.63
2	Implement GHS on mixture with estimation techniques	3.65	0.70	4.01	0.73	4.960***	0.000	0.50
3	Business entities to test and classify by themselves	2.78	0.96	3.65	1.05	8.534***	0.000	0.86
4	Business entity to outsource chemical classification	3.50	0.92	3.70	1.04	1.992*	0.047	0.20
5	Government to commission non–profit organizations for conducting testing and classifications	4.16	0.80	4.28	2.74	0.514	0.607	0.06
6	Implement GHS for employees	3.98	0.78	4.19	0.69	2.854**	0.004	0.29
7	Implement GHS for transporters	4.21	0.68	4.17	0.73	–0.612*	0.541	0.06
8	Implement GHS for emergency responders	3.94	0.77	4.17	0.76	2.952**	0.003	0.30
9	Implement GHS for chemical suppliers	4.20	0.69	4.22	0.75	0.143	0.886	0.03
10	Implement GHS for chemical manufacturers	4.27	0.70	4.20	0.77	–0.906	0.365	0.10
11	Implement GHS for chemical users	3.98	0.73	4.13	0.74	1.949	0.052	0.20
12	Implement GHS for ordinary consumers	3.31	0.82	3.88	0.81	6.675***	0.000	0.70
13	Implement GHS for manufacturing industry	4.15	0.72	4.13	0.70	–0.303	0.762	0.03
14	Implement GHS for construction industry	3.46	0.76	4.09	0.72	8.025***	0.000	0.85
15	Implement GHS for service industry	3.42	0.80	3.93	0.81	6.190***	0.000	0.63
16	Taiwan to implement GHS with other countries	3.90	0.77	4.11	0.73	2.744**	0.006	0.28
17	Establish MSDS according to GHS	4.07	0.77	4.14	0.71	0.933	0.351	0.09
18	Industry to establish MSDS according to GHS	4.02	0.78	4.01	0.80	–0.027	0.979	0.01
19	Government to establish MSDS for GHS	4.12	0.75	4.16	0.69	0.570	0.569	0.06
20	Industry to establish labeling system according to GHS	4.05	0.70	3.98	0.81	–0.881*	0.379	0.09
21	Government to establish labeling system according to GHS	4.04	0.79	4.15	0.71	1.466	0.143	0.15
22	Industry to establish hazardous chemicals control database for GHS	3.92	0.80	4.03	0.81	1.329	0.185	0.14
23	Government to establish hazardous chemicals control database for GHS	4.13	0.75	4.16	0.70	0.429	0.668	0.04
24	Industry to conduct GHS test and classification on mixtures	3.39	0.90	3.78	1.02	3.891***	0.000	0.41
25	Government to conduct GHS test and classification for mixtures	3.88	0.78	4.10	0.77	2.731**	0.007	0.28
26	Industry to conduct GHS test and classification for new chemicals	3.53	0.94	3.82	1.02	2.789**	0.005	0.30
27	Government to conduct GHS test and classification for new chemicals	3.97	0.86	4.15	0.73	2.074*	0.039	0.23
28	Establish effective training systems for employees according to GHS	4.14	0.69	4.21	0.71	0.904	0.367	0.10
29	Schools to implement labor safety and health education and training according to GHS	4.03	0.79	4.18	0.72	1.975*	0.049	0.20
30	Taiwan to implement chemical registration, declaration and control (EU Reach system)	3.89	0.77	4.17	0.76	3.491***	0.001	0.37
31	Seamlessly connect GHS to REACH	3.84	0.77	4.08	0.73	3.051**	0.003	0.32
32	Enforce standardized regulations to manage hazardous materials according to GHS	3.80	0.87	4.14	0.69	4.034***	0.000	0.43
33	Add GHS into type 1–9 labels and healthy, ecological, and warning labels according to GHS and existing transportation symbols	3.85	0.77	4.16	0.67	3.963***	0.000	0.43
34	Uniformly regulate transportation symbols on appearance of transported materials and contents and GHS	3.98	0.74	4.20	0.68	3.079**	0.002	0.31
35	GHS adopt train the trainer approach for GHS implementation	3.93	0.73	4.13	0.72	2.681**	0.008	0.28
36	GHS adopt e–learning approach to implement GHS	3.72	0.79	3.79	0.92	0.700	0.484	0.08
37	Effectively and interdepartmentally integrate GHS related regulations	3.93	0.80	4.20	0.74	3.456***	0.001	0.35
38	Set up trade secret protections for chemical labels	3.81	0.82	3.96	0.81	1.759	0.079	0.18
39	GHS implementation requires regulatory enforcement from government	3.94	0.82	3.96	0.81	1.759	0.079	0.02
40	Government to provide technical guidance on GHS implementation for SME	4.06	0.74	4.14	0.72	1.177	0.240	0.11
41	Government to provide technical guidance on GHS implementation for large enterprise	4.04	0.73	4.16	0.69	1.662	0.097	0.17
42	Urge industry to gradually establish standard to control GHS specified hazardous chemicals	4.02	0.74	4.17	0.70	2.100*	0.036	0.21
43	Promote implementation buffer period of consumer labeling system	3.80	0.81	4.05	0.75	3.127**	0.002	0.32
44	Integrate the EU REACH system into the enabling statute of Labor Safety and Health Act, and risk assessment reports covering the manufacturing and importing processes should be submitted to the relevant government authorities.	4.09	0.63	4.12	0.73	0.059	0.953	0.04
45	Promote GHS system through public media	4.60	0.80	4.14	0.72	1.076	0.282	0.60
46	Promote GHS system through the school system	4.08	0.78	4.16	0.74	1.042	0.298	0.11

*statistically significant *$p<0.05$ **$p<0.01$ ***$p<0.001$.

Table 5. Logistic regression model–positive influence of GHS implementation on improving hazard awareness for transporters

Independent variable	B	SE	odds ratio	95%CI for odds ratio	
				Lower	Upper
X1	–0.124	0.167	0.884	0.637	1.226
X2	0.000	0.250	1.000	0.612	1.634
X3	0.647*	0.311	1.909	1.037	3.516
Constant	2.181	0.822	8.859		

*statistically significant *$p<0.05$ **$p<0.01$ ***$p<0.001$. X1: Years of experience at the current position; X2: Hours spent on previous version of general education and trainings on hazards; X3: Hours spent on education and trainings of new GHS systems.

Table 6. Logistic regression model–negative influence of weak labeling ability on GHS implementation

Independent variable	B	SE	odds ratio	95%CI for odds ratio	
				Lower	Upper
X1	0.227	0.185	1.254	0.873	1.803
X2	–0.238	0.259	0.788	0.475	1.309
X3	1.539**	0.562	4.660	1.548	14.030
Constant	0.381	0.897	1.464		

*statistically significant *$p<0.05$ **$p<0.01$ ***$p<0.001$. X1: Years of experience at the current position; X2: Hours spent on previous version of general education and trainings on hazards; X3: Hours spent on education and trainings of new GHS systems.

tion will improve hazard awareness for transporters. This is because the case company is deploying both the new and old systems in parallel to label chemical containers to be transported, and employees who are used to the existing labeling system have not accepted the new GHS system. Thus, their perception toward the hazard labeling system still remains to prefer the old system (characterized by the nine major categories). The B_2 is 0.000 for X_2, indicating that the more hours an employee spends on the previous version of general education and trainings on hazards, the less likely that employee will think GHS implementation will improve hazard awareness for transporters. Furthermore, B_3 is 0.647 for X_3 and the odds ratio for X_3 is 1.909 with a 95% confidence interval for the odds ratio is (1.037, 3.516), indicating that the more hours an employee spends on education and trainings of new GHS systems, the more likely that employee will think implementation of GHS will improve hazard awareness for transporters. This highlights the importance of promoting GHS training and education.

(b) From the results of negative influence of weak labeling ability on GHS implementation (Table 6), the B_1 is 0.227 for X_1, indicating the longer an employee stays at a job, the more likely that employee will think weak labeling ability will affect deployment of the new GHS system. And the B_2 is −0.238 for X_2, indicating that the more hours an employee spends on the previous version of general education and trainings on hazards, the less likely that employee will think weak labeling ability will not affect deployment of the new GHS system. Moreover, B_3 is 1.539 for X_3 and the odds ratio for X_3 is 4.660 with a 95% confidence interval for the odds ratio is (1.548, 14.030), indicating that an employee who has receive training on the new GHS system will understand better the importance and details on GHS labels and think that weak labeling ability will affect deployment of the new GHS system.

(5) Logistic Regression Analysis on Importance and Feasibility Indicator of GHS Implementation

(a) In the logistic regression model, three independent variables (X_1, X_2, X_3) are adopted to predict the dependent variable, importance of business entities to test and classify by themselves (1: important; 0: unimportant). As the results shown in Table 7, B_1 is −0.285 for X_1, indicating the longer an employee stays at a job, the less important that employee is to conduct self-tests. The B_2 is −0.251 for X_2, indicating that the more hours an employee spends on the previous version of general education and trainings on hazards, the less likely that employee will think it is important for business entities to conduct tests and classification by themselves. And the B_3 is 0.246 for X_3, indicat-

Table 7. Logistic regression model–importance and feasibility indicator measuring business entity conducting self tests and classifications

Independent variable	B	SE	odds ratio	95%CI for odds ratio	
				Lower	Upper
A. Importance indicator					
X1	–0.285*	0.143	0.752	0.568	0.995
X2	–0.251	0.202	0.778	0.523	1.157
X3	0.246	0.192	1.278	0.878	1.862
Constant	3.797	0.769	44.548		
B. Feasibility indicator					
X1	–0.458***	0.115	0.632	0.505	0.792
X2	0.208	0.189	1.231	0.85	1.782
X3	–0.523**	0.179	0.592	0.417	0.841
Constant	4.359	0.637	78.217		

*statistically significant *p<0.05 **p<0.01 ***p<0.001. X1: Years of experience at the current position; X2: Hours spent on previous version of general education and trainings on hazards; X3: Hours spent on education and trainings of new GHS systems.

ing that the more hours an employee spends on education and trainings on new GHS systems, the more likely that employee will think it is important for business entities to conduct tests and classification by themselves.

(b) From the results (Table 7) of feasibility analysis of business entities to test and classify by themselves (1: feasible; 0: infeasible), the B_1 is −0.458 for X1, indicating the longer an employee stays at a job, the more likely that employee will think it is not feasible for business entities to conduct tests and classification on their own. The B_2 is 0.208 for X_2, indicating that the more hours an employee spends on the previous version of general education and trainings on hazards, the more likely that employee will think it is feasible for business entities to conduct tests and classification on their own. However, the B_3 is −0.523 for X3, indicating that the more hours an employee spend on GHS training, the better that employee will understand the GHS system, and the less likely that employee will think it is an vital idea to conduct tests and classification on their own due to the foreseeable difficulties that are likely to occur in GHS implementation.

Discussion

As revealed from the positive influence on GHS implementation, the average score of the 12 issues for experts is below four, and the indicator of improve international competitiveness has the highest score. The average score of the 12 issues for employees is above four, indicating that employees think that GHS system should be implemented with high priority. Improve eco-environmental quality has the highest score, and it is followed by improve health and safety protection for employees. There are a total of 9 issues to gauge the negative influence on GHS implementation. Experts think that difficulty to acquire relevant information exhibits the highest level of influence, and it is followed by weak classification ability. Employees think that incomplete regulation has the highest level of influence while insufficient funds for classification and labeling is the second influential issue. It is inconsistent with the hypotheses 1: The employer and employee have the executive ability about GHS implementation. However, the barrier associated with GHS implementation is existed; it is feasible to overcome them first.

There are a total of 46 issues gauging the heterogeneity among importance indicators of GHS implementation, and 11 of which have achieved statistical significance. Compared to experts, employees think that GHS implementation is more important, and this may be because that employees have gained a better understanding about the hazards associated with chemicals from their hands-on experiences. There are a total of 46 issues gauging the heterogeneity among feasibility indicators of GHS implementation, and 27 of which have achieved statistical significance. Experts and employees both rate lower on business entities to test and classify by themselves, as they both think that business entities are insufficient to test on their own. Experts seem to understand better about the associated difficulty than do employees and GHS implementation is not possible without technical guidance from the government. It is inconsistent with the hypotheses 2: There is no difference for the GHS perception between the experts and employees.

From the logistic regression analysis, the more hours an employee spends on education and trainings of new GHS systems, the more likely that employee will think implementation of GHS will improve hazard awareness for transporters. Meanwhile, employees think that it is neither important nor feasible for business entities to test and classify by themselves; and an employee who has received training on the new GHS system will think that weak labeling ability will affect deployment of the new GHS system, and the more training hours an employee has, the more likely that employee will think it is feasible for business entities to conduct tests and classification on their own. It highlights the importance of promoting GHS training and education.

Limitation

This study was limited to the time, man power, and materials for advancing the GHS system. In this work, the cost-effect analysis was not applied; hence the comparison on economical effect was not available. And limited to the time and man power, the chemical plants, high-tech industry, and other small-medium scale companies were not included in this research. The cost-effect analysis and different kinds of companies are suggested to be investigated in further works.

Conclusions

Although GHS was applied to dangerous and harmful materials regarding to the Regulation of Labeling and Hazard Communication of Dangerous and Harmful Materials on December 31, 2008, the barrier associated with GHS implementation (e.g. the difficulty to acquire relevant information, incomplete regulation, insufficient funds for classification and labeling) is existed; it is feasible to overcome them first. Both experts and employees think that business entities are insufficient to test and classify chemicals on their own. Results of the logistic regression model indicate that the more hours an employee spends on education and trainings of new GHS systems, the more likely that employee will think implementation of GHS will improve hazard awareness for transporters and the weak labeling ability will affect deployment of the new GHS system.

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