

Adoption of Inherently Healthier Design in Malaysia – Where Are We Now?

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Abstract. Inherently healthier design is a new concept focusing on developing a process which is fundamentally healthier through the selection of less toxic and volatile chemicals, milder operating conditions and better working procedures that may reduce workplace exposures. Since the idea is relatively new compared to inherent safety, it is interesting to know the level of understanding of the concept as well as the level of adoption of the design new features in Malaysia. A national level survey was carried out to determine the level of knowledge and adoption of inherent occupational health (IOH) concept in Malaysia. It was found that among the three sectors, the industrialists have the lowest awareness of the IOH concept; as compared to academics who have highest awareness level. Among the common reasons given by the respondents for their lack of knowledge related to the IOH are weak regulation's enforcement related to health aspect, low safety and health mentality and culture in developing countries, and poor recording of workplace related diseases in Malaysia.

Keywords: Inherent Healthier Design; Occupational Health; Survey; Malaysia; ISD

1. Introduction

Safety, health, and environmental (SHE) assessment is very important in chemical process design. The concept of inherent safety which was introduced in 1970s professes that hazards that might arise in an operating process should be identified early, that is when the plant is still 'on paper'. In order to avoid accidents or hazardous events, it is better to design the plant to be inherently safer, healthier, and environmentally friendlier, rather than installing add-on systems to control hazards. In principle, the inherently safer design (ISD) features can also be extended to the environmental and health criteria [1]. Compared to safety and environmental criteria, the concept of inherently healthier design of process industries is relatively new and has not been widely researched. Many do not realize that the number of people die from diseases caused by work is gradually increasing with new chemicals and new technologies are being introduced every year, which present new and often unknown hazards to both workers and community. The occurrence of occupational health effect however, is long-term and less dramatic compared to sudden and major disasters (e.g. caused by safety-related events). The insidious nature of occupational disease is the reason for it rarely reaches the news, is not well publicized, and consequently contributes to low level of awareness especially among the industrial communities towards the occupational health risk.

The objective of this study is to determine the current status of inherent occupational health concept and design in Malaysia. A survey was conducted amongst the academics, industrialists, and R&D engineers in Malaysia. Similar study has been conducted successfully by Gupta and (C) Persatuan Saintis Muslim Malaysia (PERINTIS)

Edwards in year 2002 [2] on inherent safety globally. They found that the level of ISD adoption was very limited due to the lack of knowledge on the indices developed for ISD and some thought that the indices as too complicated. It is interesting to study on inherent health aspect as well; but with a smaller sampling on scenario in Malaysia for a start.

2. Methodology

2.1.Design of Questionnaires – Manual and Online

The questionnaires were designed carefully in a way that it should be able to extract the information desired from the respondents and subsequently, achieve the objective of the study. Three different sets of questionnaires were developed for different target groups, i.e. industries (including engineers, managers, operators, subcontractors); universities (academia, researchers); and R & D organizations (engineers and scientists). The purpose of the survey and the instructions to respondents were clearly specified. Basically the questions are based on those designed by Gupta and Edwards [2], but modified to inherent occupational health discipline. The development of the questionnaires went through two phases. In the beginning of the study, a manual based questionnaire was designed and disseminated to respondents. However we received feedbacks from several respondents that it is tedious to fill in the questionnaires manually and subsequently having to scan the form and send it back to us through email. Therefore, the questionnaires were upgraded into computerized based questionnaires where the survey was conducted online. The new questionnaires have received much better responses besides getting back the feedbacks so much faster compared to the manual questionnaires. The questionnaires for the industries are in Appendix A and for the academics as well as the R&D are in Appendix B.

2.2.Conducting the Survey

The questionnaires were distributed amongst the industrialists, academics, and R&D engineers in Malaysia. The first version of the questionnaires were distributed among workers in YTL Power Services Sdn. Bhd. in PasirGudang as pilot study. Henceforth, the questionnaires were distributed to 80 local companies, 50 academics in all local universities, and 20 engineers and scientists in the R&D organizations. The questionnaires were distributed via email and by hand. Interview sessions were also conducted upon having a chance to meet the respondents face to face. Conducting interview was found to be more efficient as the information acquiring process was done interactively and this has been approached by a team in Japan who surveyed on the status of OSH management for non-regular workers on the premises in Japan [3].

3. Results and Discussion

3.1.Academia/University

Around 50% of the questionnaires distributed to the universities were completed and returned back to us within two weeks. At least one respond from each university offering chemical engineering in Malaysia was received. The survey finds that only 38% of the responders are (C) Persatuan Saintis Muslim Malaysia (PERINTIS)

aware of the Inherent Occupational Health (IOH) concept from university lectures (50%), journals or books (75%), and training materials (25%). The others have heard of inherent safety but not the IOH term. One of the responders' comment was that, he does not even know clearly the difference between occupational safety and occupational health. Another described the IOH concept as '*reducing the hazard and risk for a specific process from the beginning of the design stage through minimization, intensification, elimination, and etc.*', which is generally correct, but more related to inherent safety rather than health. Most of the responders presume that the IOH concept should be applied throughout the process with higher preference during process design stage (71%).

Also, more responders think that the concept applies on operational phase rather than the R&D. This somehow shows that they do not totally get the idea of IOH concept; which is in principle gives greater benefits upon being adopted earlier in the development and design stage, instead at the later stages of process lifecycle. Another interesting finding is 62% of the responders shared that their university do not include IOH subject in their undergraduate programmes' syllabus, whereas the other 38% claimed that they do teach the IOH concept to the students. We personally think that the responders confused the concepts of occupational health and IOH, but these are actually two completely different things. Based on our knowledge, actually none of the universities has included IOH in the syllabus; increasing efforts have been made to introduce inherent safety to the students but not IOH.

3.2. R&D Organizations

Feedbacks from the R&D organizations were 45%, which include well-established R&D organizations in Malaysia. Around 67% of the responders are aware of the IOH concept from in-house courses (17%) besides university lectures and journals or books. One of the responders wrote that the IOH concept is '*all about using the right chemical or raw material at the workplace to promote better occupational health environment*'. This is a very good comment, indicating a good knowledge of the respondent on the IOH concept. We believe that he stressed on the raw material since he is involving with the R&D – and the approach is particularly correct, that is to prioritize on materials substitution (if possible) at this stage in order to develop an inherently healthier process. A significant percentage of 89% of the respondents have not applied the IOH design features in their R&D related works.

3.3. Industries

The feedbacks from the industrialists were 40%. The questionnaires were disseminated throughout Malaysia, which includes well-established multinational companies producing wide range of products e.g. Petronas, Shell, Polyplastics Asia Pacific, Aker Solutions etc. Most of the respondents are engineers and some are the HSE managers. The survey found that 62.5% respondents do not know what IOH concept is all about; claiming that they have never heard of the term before. The lacking of knowledge of this concept is the worst among the industrialists compared to the academics and R&D organizations. This is not surprising since many also shared that even 'inherent safety' is new to them. For the rest who are aware of the IOH, almost 50% of them learnt the term from in-house and external courses and around 30% through informal learning (i.e. via internet). This shows that the desire of learning the new concept is

there within the industrialists, but the companies need to put more efforts to support their employees to obtain the knowledge and skills from the experts.

As for implementation, not even one company has ever applied the concept in any of their process stage before. Most of them still cannot appreciate the significance of adopting the IOH concept when developing or operating the process; instead they assume this to be totally under the management's responsibility (to be specific, the HSE manager) and is only related to regulations enforcement, etc. One of the respondents from a well-known petrochemical company commented that *'HSE department should be more familiar with the concept and the concept is more applicable to them rather than the process department'*. The wrong perception needs to be corrected because from the inherent safety/health point of view, process designers and engineers are the best person to adopt new design features maximally since they understand the process the most. Besides, they involve in developing the process starting from the very first beginning. Their early decisions are actually those that will affect the later performance of a process rather than the HSE manager who usually gets involved only after the plant is operating.

4. Expansion of Questionnaires

The results of the study have been presented in the Hazards Asia Pacific Symposium, dated 27-29 September 2011 in Kuala Lumpur. This symposium was well-received as this is the first time such IChemE event is conducted in Asia Pacific country. Majority of the participants are from the industries – both local and international; there were also a few of them from universities as well as government sectors. Our paper was presented under the theme of 'Inherently Safer Process Design'. The presentation did grabbed full attention from the audiences since it was the first time the subject of inherent occupational health was discussed. Several feedbacks were received both during as well as after the presentation from the industrialists. They shared that in Malaysia it is a mandatory requirement for a company using hazardous chemicals to conduct a Chemical Health Risk Assessment (CHRA) under a new regulation known as the Use and Standards of Exposure of Chemicals Hazardous to Health (USECHH) Regulations 2000. The CHRA seeks to identify, evaluate and control any health risk associated with work activities involving the use of chemicals. Based on our review on the CHRA, CHRA is a very good document offering a comprehensive assessment for chemical exposure risk. It includes both the chemical health impact and exposure aspects, which are necessitated in any health risk assessment. In terms of application, we found that the CHRA is more suitable for existing, operating facilities. The chemical hazards/impacts assessment can be conducted for proposed (in the design stage) and existing plants since the data needed are available from the MSDS or equivalent data sources i.e. R-phrase, LD50, LC50 etc. However for the exposure assessment part, the approach is suitable only for existing facilities; in fact it gives a proper, thorough evaluation for such facilities. The method however, is not applicable for processes which are still under development and design phase since it requires data beyond this phase. This issue is not only encountered in the CHRA but also in most of the available methods worldwide for health risk assessment [4-5]. Koller et al. [6] claimed that for early design phases, the chemical effects can be evaluated but not the exposure aspect due to the data unavailability. This is among the reasons health risk (especially to workers) is rarely assessed in development of a new plant or facility – which is what the inherent occupational health concept is all about.

5. Conclusions

A national level survey has been carried out to determine the level of knowledge and adoption of IOH concept in Malaysia. A total of 65 local and international personnel, from three different sectors, i.e. industries, universities, and R&D organizations have responded. Among the three sectors, the industrialists have the lowest awareness of the IOH concept; as compared to academics who have highest awareness level. Among the common reasons given by the respondents for their lack of knowledge related to the IOH are weak regulation's enforcement related to health aspect, low safety and health mentality and culture in developing countries, and poor recording of workplace related diseases in Malaysia.

Among the recommendations given by the respondents to increase the knowledge and adoption are:

- Enforcement for early consideration of IOH in process development in Malaysia, as approached by the IPPC and Responsible Care.
- Mandatory adoption of the IOH features in areas evaluated to be high risk.
- Educating the top management on the importance of IOH so that they will provide relevant supports to employees.
- Promotion through the IChemE, which is very supportive in safety and health related initiatives.
- Active publications e.g. in local newspapers, IEM bulletins, magazines (Chemical Engineering Progress, the Chemical Engineers), etc.
- Workshops and seminars by the experts (*recently the author has just conducted a workshop on the IOH at the Institution of Engineers Malaysia and the participants came from various disciplines including electrical and mechanical engineering*).
- Embedding the IOH concept in students' final year design project (process route is selected not solely based on profitability anymore, but also other sustainable aspects of SHE).
- Introducing new modules related to IOH for undergraduates and postgraduates (*next semester, the author will be teaching a new module on the IOH assessment in process design for Masters in Chemical Engineering program in UTM*).

However based on the feedbacks from presentation in a symposium on the results of this study, we believe that the respondents (especially the industrialists) do know of the concept of evaluating chemical health risks due to exposures in workplaces, but different term is used (they are very familiar with the CHRA and not the IOH). A comprehensive method for the assessment is available since 2000 and is being well adopted throughout Malaysia; however continuous efforts need to be done to encourage the evaluation to start being considered during the early design stage rather than on the operating facility especially related to the subject of chemical exposure.

6. Recommendations

Due to the well-received studies, we plan to extend the work by getting more responses from all the three sectors. We have identified a lot more potential responders and will approach them by e-mail. The study now becomes easier and more efficient with the aid of online survey. We believe that higher responses will give more representative results that indicate the level of adoption and knowledge of the inherently healthier design concept in Malaysia.

References

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Appendix A: Questionnaires for Industries

Questionnaires in Inherent Occupational Health (IOH) for Industries

(A) Personal Information

Name of respondent:

Age:

Gender:

Phone:

E-mail:

(B) Working Information

Company name:

Address:

Job position:

No. of years working:

Phone:

E-mail:

Web site:

No. of employees (approx.):

(C) Chemical Health Risk Assessment (CHRA)

- 1) Are you aware of the Chemical Health Risk Assessment (CHRA)? Yes / No
- 2) Is the CHRA concept being conducted in your work place? Yes / No
- 3) What the Chemical Health Risk Assessment (CHRA) is all about?

- 4) Have you personally experiencing conducting CHRA in your workplace? Yes /No
If yes, a) describe what you have done with this assessment?

- 5) Based on your personal opinion, do you think CHRA is suitable for evaluating hazard in early design stage
i.e. R&D? Yes / No

(D) General Understanding on the Inherent Occupational Health (IOH) Concept

Please tick as many as applicable and specify in details where appropriate.

- 1) Are you aware of the Inherent Safety concept? Yes / No
- 2) Are you aware of the IOH concept? Yes / No
If yes, a) When did you heard of the IOH concept?

b) Where did you learnt/knew it from?

- ☐ External short course
- ☐ In-house course
- ☐ University lecture
- ☐ Conference
- ☐ Journals or books
- ☐ Training material by e.g. IChemE, IEM
- ☐ Other (specify) _____

c) Can you briefly explain what the concept is all about?

- 3) If you are not familiar but are interested in knowing more, we would be glad to refer you to some articles.
Would you like us to? Yes / No

*If you are familiar with the IOH concept and have used them, please go to **Section (I)**.
If you are familiar but have not used them, please go to **Section (II)**.*

Section (I)

- 1) Please describe the situations in which you have used or are using IOH.
- 2) In your opinion, at what product/process lifecycle stage does the IOH concept apply?
- ☐ R&D stage
- ☐ Process development and design
- ☐ In an operating plant
- ☐ Others (specify) _____
- 3) What products were being produced or planned to be produced in your plant?
- _____
- 4) What specific health hazards did you target your applications of IOH to eliminate/minimize?
- ☐ Hazardous/toxic nature of chemicals
- ☐ Releases/emissions of process chemicals
- ☐ Harmful operating conditions
- ☐ Complex design of plants,
- ☐ Unhealthy work procedures/activities
- ☐ Worker exposure to process chemicals
- ☐ Others (specify) _____
- 5) What broad actions did you take?
- ☐ Install less leaking piping equipment e.g. sealless pump
- ☐ Use milder pressure, temperature, concentration
- ☐ Substitution by less hazardous/toxic chemicals
- ☐ Simplifying the plant design for more friendly/less emissions operation
- ☐ Reduce manual operations
- ☐ Others (specify) _____
- 6) What were the results of the above with regards to the reduction in hazards, risks, insurance costs, capital and operating costs, manpower costs, compliance with regulations, employee confidence, acceptance by nearby community, others?
- _____

- 7) What new hazards, if any, were introduced by application of IOH? _____
- 8) What was the cost, if any, of IOH implementation? What is the expected payback period? _____
- 9) Considering the difficulties you might have had in getting approvals to apply IOH on your plant and any recognition that might have come your way, do you think it was worth the effort? Would you do it again? It may be easier next time with your credentials already established.

Are there instances of IOH usage that you cannot reveal due to their proprietary nature and the competitive advantage these might have given your company? Yes / No.

- 10) Are you familiar with the Inherent Occupational Health indices/methods developed by a couple of researchers to rank different processes/designs with regards to inherent health (normally during the R&D stage)? Yes / No.
- 11) Are you familiar with the Inherent Occupational Health indices/methods developed by a couple of researchers to evaluate inherent health aspect of processes beyond R&D stage e.g. at pre-design and basic engineering stages? Yes / No.
If yes, what is your opinion about these indices as to their user friendliness, items to be added/deleted etc? _____
- 12) Have you used these indices in your work? Yes / No.
- 13) What is your overall opinion about the IOH concepts and how should their use be made more widespread at an accelerated pace? _____

Section (II)

Reasons for not using IOH even though you are familiar with it. Please tick as many as applicable and specify in as much detail as possible. Also add other reasons you can think of, to aid in devising ways to spread the use of IOH.

- ☐ The management did not permit due to their lack of faith in the predicted health and/or cost benefits of IOH.
- ☐ We have analysed the current IOH concepts and they will not work on our plant.
- ☐ The management is convinced of the benefits of IOH. We will use them when our financial situation improves/in our new plant.
- ☐ We are going out of this product in the near future. Hence, we do not wish to invest in this plant any more.
- ☐ We have recently put in a lot of money in less leaking and better systems. We cannot ask the management to put in more for IOH. Our plant is healthy now.
- ☐ Our analysis showed that the new hazards that IOH will introduce will not be less than the current hazards.
- ☐ We are not familiar with any regulatory requirements to adopt IOH concepts.
- ☐ We are shifting production to countries with less strict laws so as to be competitive and hence do not need to implement IOH regimes on the existing plants.
- ☐ There are no definitive methodologies/tools available to evaluate different designs with regards to IOH. When these have been developed and certified by a professional or statutory body, we will use them.
- ☐ The tools being developed appear to be too complicated. We need a quick way to get an answer as to whether or not to do a detailed analysis for IOH.
- ☐ Our experience with add-on control measures has been very good indeed. We have not had any major health problems among our workers. Management wants to play it safe using time tested systems and

procedures. We do not see a need to divert from this unless regulatory pressure builds up or we see numerous successful cases.

- ☐ Since the IOH concepts are very new with little open information on their successful working under different situations to give confidence, there is no use risking any operations as expected. If successful uses of IOH, both with regards to the health benefits and cost (initial/lifetime) were disseminated broadly, our management too would look at IOH favourably.
- ☐ First, I have to convince the management, then make the changes with a reluctant staff and then risk my job in case of failure to get the expected results. Why should I do this? If I am successful, the management will take the credit, otherwise my neck will be on the block.
- ☐ Our licensor will not guarantee production if we change the design/catalyst/raw materials/operating conditions.
- ☐ As far as I know the application of IOH is at the process development level by the research chemists. I am a design engineer and not a researcher. I have to design a plant based on the process developed by the chemists. I don't know if IOH can be used at later stages as well.
- ☐ Cost of health breaches is not taken into account in economic analysis for a new plant. If it was, probably the management will be more responsive to IOH.

Add other reasons you can think of, to aid in devising ways to spread the use of IOH.

Appendix B: Questionnaires for Academics and R&D Organizations

Inherent Occupational Health (IOH) Questionnaires for Academic and R&D Organizations

(A) Personal Information

Name of responder:

Age:

Gender:

Phone:

E-mail:

Highest education level:

(B) Working Information

Organization/University:

Address:

Job title & department:

No. of years working:

Phone:

E-mail:

(C) Chemical Health Risk Assessment (CHRA)

6) Are you aware of the Chemical Health Risk Assessment (CHRA)? Yes / No

7) Is the CHRA concept being conducted in your work place? Yes / No

8) What the Chemical Health Risk Assessment (CHRA) is all about?

9) Have you personally experiencing conducting CHRA in your workplace? Yes /No
If yes, a) describe what you have done with this assessment?

10) Based on your personal opinion, do you think CHRA is suitable for evaluating hazard in early design stage
i.e. R&D? Yes / No

(D) General Understanding on the Inherent Occupational Health (IOH) Concept

Please tick as many as applicable and specify in details where appropriate.

1) Are you aware of the Inherent Safety concept? Yes / No

2) Are you aware of the IOH concept? Yes / No

If yes, a) When did you first heard of the IOH concept?

b) Where did you learnt/knew it from?

☐

External short course

☐

In-house course

☐

University lecture

☐

Conference

☐

Journals or books

☐

Training materials e.g. by the IChemE, IEM

☐

Others (specify) _____

c) Can you briefly explain what the concept is all about? _____

- 3) At what product/process life cycle stage do you think the IOH concept does apply?

☐ Product R&D

☐ Process and Design

☐ Operating plant

☐ Other (specify) _____

(E) Adoption of the IOH Concept at Work

- 1) Is the IOH concept being practiced in your work place? Yes / No
If yes, please explain briefly how it is being practiced in your work place?

- 2) Is discussion of IOH issues included in your organization's meeting? Yes / No

If yes, a) How frequent it was discussed in meetings?

☐ Every meeting

☐ Once in a while

☐ When there is case/issue arise

☐ Others (specify) _____

b) What are the issues that have been discussed? _____

- 3) Add the strategies you can think of, to aid in devising ways to spread the use of IOH.

If you are working in an academic organization, please answer Section (E).

If you are working in R&D organization, go to Section (F).

(F) Academic Organization:

- 1) Is IOH subject included in your undergraduate programmes' syllabus? Yes / No
- 2) Do you think it is important to teach this concept to undergraduate students? Yes / No
- 3) Is there any lecturer specialized/researching in IOH in your department? Yes / No
- 4) Has there been any research conducted related to IOH in your department? Yes / No

If yes, at what level?

☐ Doctoral study (PhD)

☐ Master (MSc)

☐ Grant/Consultation project

☐ Undergraduate project

☐ Others (specify) _____

- 5) Would knowledge of IOH influence research in chemistry/chemical engineering?
Yes / No

- 6) How can one get the chemistry and chemical engineering faculties to be involved with IOH?

- 7) Is handout of IOH concept circulated to staffs/students to increase their awareness on this issue? Yes / No
If yes, how frequent the handout of IOH concept was circulated?

☐ Every week

- ☐ Every two weeks
- ☐ Every month
- ☐ Others (specify) _____

- 8) Have all staffs/students been made aware of their IOH responsibilities? Yes / No
If yes, how they were made aware of their IOH responsibilities?

- 9) What role can your department play in promoting IOH?

- 10) Have your department conducted any survey on the use of IOH in industry? Yes / No
If yes, can you briefly explain the survey that has been conducted?

(G) R&D Organization:

- 1) Does your company apply IOH concept in the R&D of new product/process? Yes / No
- 2) Is there a health officer/expert hired for your organization? Yes / No
If yes, what is his/her job scope?

- 3) What is the impact of IOH on R&D organization practices?

- 4) Is the rate at which R&D organization adopting IOH adequate? Yes / Slow
If slow, what do you think are the reasons for it?

- 5) What should be done to increase this rate?

- 6) Do you know the existing Inherent Occupational Health (IOH) indices? Yes / No
If yes, what is your opinion about the indices?

- 7) What role can your organization play in promoting IOH?

- 8) Is handout of IOH concept circulated to staffs to increase their awareness on this issue?
If yes, how frequent the handout of IOH concept was circulated?
☐ Every week
☐ Every two weeks
☐ Every month
☐ Others (specify) _____
- 9) Have all staffs been made aware of their IOH responsibilities? Yes / No
If yes, how they were made aware of their IOH responsibilities?

- 10) What do you think are the issues or problems that hinder the adoption of the IOH concept in your organization?
