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## A conceptual framework for the adoption and implementation of product stewardship in the chemical industries

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### Abstract

A conceptual framework for product stewardship is proposed to govern the adoption and implementation of this voluntary initiative in the chemical industries. The success of product stewardship depends very much on the management leadership and commitment, participations from stakeholders, namely employees, suppliers, contract manufacturers, distributors and customers. This conceptual framework provides a basis for governing the adoption and implementation of product stewardship, moving beyond to a more comprehensive understanding of the principles. It is an initial overview of which the producer and stakeholders are linked with their respective management practices and serves as a basis for the development of future tools that could be used to enhance the effectiveness of product stewardship.

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**Keywords:** product stewardship; chemical industries; conceptual framework; risk communication; management; sustainability

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## 1. Introduction

Chemical industries are the second largest contributor to the total manufacturing exports, accounting to about 6% of the total Malaysian exports annually. The manufactured chemical products include refined petroleum products, vegetable and animal oils and fats, basic chemicals, fertilizers and nitrogen compounds, plastics and synthetic rubber in its primary forms [1]. Chemical products are used almost everywhere in our daily lives. If they are not managed properly, they can cause adverse impact to the environment, human health and safety [2]. Therefore, effective management practices are needed to prevent all kinds of impact from the products and services including all aspects of safe, responsible and economical handling of chemical products [3].

Product stewardship is a concept of responsibility for a chemical product throughout its lifecycle which is central to the industry's approach to business. It focuses on the environmental, health and safety implications of a product from inception through final disposal [4, 5]. In Malaysia, product stewardship is incorporated as one of the codes of management practices under Responsible Care program [6]. However, Chemical Industries Council of Malaysia (CICM), being the steward of Responsible Care program in Malaysia reported that product stewardship has the lowest compliance rate as compared to other Responsible Care codes and it needs attention by the signatories<sup>1</sup>. Therefore, there is a need to develop a holistic framework to improve the adoption and implementation of product stewardship in the chemical industries.

This paper aims to integrate critical principles into the product stewardship conceptual framework. The first section provides an overview of management practices of stakeholders in product stewardship. The second section reviews the principles to be integrated into the product stewardship conceptual framework. The last section proposes a conceptual framework for the adoption and implementation of product stewardship in the chemical industries.

## 2. Management practices of the stakeholders

In November 1999, product stewardship code was launched as one of the Responsible Care codes of management practices with the objective to make health, safety and environmental protection as an integral part at all stages of a chemical product from initial research and development, to manufacture and distribution and final disposal. Product stewardship code requires everyone involved in handling and use of chemical products to be responsible and to help maintain a safe and healthy environment. The code is in line with Responsible Care guiding principles, whereby it aims to develop and produce chemicals that can be manufactured, transferred, used, and disposed off, safely. It also makes health, safety and environmental considerations a priority in planning for existing and new products and processes. Product stewardship report information on chemical-related health or environmental hazards, and recommend protection measures to employees, customers, authorities and the community. Producers have the responsibility to counsel customers on safe use, transportation and disposal of chemical products; and extend knowledge by conducting or supporting research on the health, safety and environmental effects of products, processes and waste. Table 1 shows the management practices of the stakeholders, namely producer management, employees, suppliers, contact manufacturers, distributors and customers in the adoption and implementation of product stewardship [6].

Table 1 Management practices of the stakeholders<sup>6</sup>.

Stakeholder	Management practices
Management leadership and commitment	<ul style="list-style-type: none"> <li>• Demonstrate senior management leadership through written policy, active participation and communication.</li> <li>• Establish goals and responsibilities for implementing product stewardship throughout the organization.</li> <li>• Measure performance against these goals.</li> <li>• Commit resources necessary to implement and maintain product stewardship practices.</li> </ul>
Employees	<ul style="list-style-type: none"> <li>• Educate and train employees (based on job function) on the proper handling, recycling, use and disposal of products and known product uses.</li> <li>• Implement a system that encourages employees to feedback information on new uses, identified misuses or adverse effects for use in product risk characterization.</li> </ul>
Suppliers	<ul style="list-style-type: none"> <li>• Select suppliers that provide appropriate health, safety and environmental information and guidance on their products.</li> <li>• Factors adherence to sound health, safety and environmental principles into procurement decisions.</li> </ul>
Contract manufacturers	<ul style="list-style-type: none"> <li>• Select contract manufacturers who employ appropriate practices for health, safety and environmental protection for the operations under contract, or work with contract manufacturers to help them implement such practices.</li> <li>• Provide information and guidance appropriate to the product handling, use, recycling and disposal.</li> <li>• Periodically review performance of contracts manufacturers.</li> </ul>
Distributors	<ul style="list-style-type: none"> <li>• Provide health, safety and environmental information to distributors.</li> <li>• Select, work with and periodically review distributors to foster proper use, handling, recycling, disposal and transmittal of appropriate information to downstream users.</li> </ul>
Customers	<ul style="list-style-type: none"> <li>• Provide health, safety and environmental information to direct product receivers commensurate with product risk.</li> <li>• Work with customers to foster proper use, handling, recycling, disposal and transmittal of appropriate information to downstream users.</li> </ul>

### 3. Principles for product stewardship

A few sets of product stewardship principles have been proposed previously [7, 9]. However, they have some similar principles under the strategic intents, which basically can be postulated in this paper into responsibility, stakeholders engagement, financing, governance and purpose. Table 2 shows the comparison of product stewardship principles. The sets of principles proposed by Northwest Product Stewardship Council & California Product Stewardship Council [7] and Global Product Stewardship Council [8] are very much in line with the postulated strategic intents. However, Adams [9] has a different perspective on product stewardship principles whereby the 10 principles proposed can be correlated with four strategic intents. The comparison of principles shows how the principles can complement one another which are relevant to the discourse about the integration of product stewardship principles into the conceptual framework in the next section.

Table 2 Comparison of product stewardship principles

Strategic intents		Product stewardship principles		
		Northwest Product Stewardship Council & California Product Stewardship Council <sup>7</sup>	Global Product Stewardship Council <sup>8</sup>	Adams <sup>9</sup>
1	Responsibility	<ul style="list-style-type: none"> <li>• Producer responsibility</li> </ul>	<ul style="list-style-type: none"> <li>• Responsibility</li> </ul>	<ul style="list-style-type: none"> <li>• Shared responsibility</li> </ul>
2	Stakeholders engagement	<ul style="list-style-type: none"> <li>• Shared responsibilities</li> </ul>	<ul style="list-style-type: none"> <li>• Roles and relationships</li> </ul>	<ul style="list-style-type: none"> <li>• Supply chain communication</li> <li>• Stakeholders</li> <li>• Teamwork</li> </ul>
3	Financing	<ul style="list-style-type: none"> <li>• Financing</li> </ul>	<ul style="list-style-type: none"> <li>• Internalise costs</li> </ul>	-
4	Governance	<ul style="list-style-type: none"> <li>• Governance</li> </ul>	<ul style="list-style-type: none"> <li>• Flexible management strategies</li> </ul>	<ul style="list-style-type: none"> <li>• Management</li> <li>• Integration</li> </ul>
5	Purpose	<ul style="list-style-type: none"> <li>• Environmental protection</li> </ul>	<ul style="list-style-type: none"> <li>• Incentives for cleaner products and sustainable management practices</li> </ul>	<ul style="list-style-type: none"> <li>• Lifecycle thinking</li> <li>• Knowledge</li> <li>• Awareness</li> <li>• Innovation</li> </ul>

#### 4. Conceptual framework for product stewardship

A conceptual framework is proposed for the adoption and implementation of product stewardship in Fig. 1. This framework is conceptualized based on a systematic literature review on the product stewardship principles and code of management practices. Sections below illustrate the integration of principles into the management practices according to the respective strategic intent.

##### 4.1 Purpose and governance

The main purpose of product stewardship is to protect the environment, health and safety throughout the lifecycle of chemical products. Therefore, product stewardship policies should be established for the producers to design and produce “cleaner” chemical products that use less energy, materials and toxics. Product stewardship also creates incentives for the development of a sustainable and environmentally-sound system to handling, use, recycling and disposal of chemical products at the end of their lives [8]. To achieve this purpose, it requires integrated governance whereby product stewardship should be part and integral of the business culture. Product stewardship cannot be a stand-alone initiative and requires stakeholders participation. Every stakeholder contributes to the lifecycle impacts of a chemical product. However, producers have the biggest responsibility in governing product stewardship. The governance should ensure the transparency and accountability of product stewardship whereby producers are accountable to all stakeholders for disclosing environmental, health and safety information and managing risk. The management practices should continually move product stewardship forward whereby an ongoing plan-do-check-act cycle should be put in place to effectively address those risks posed by chemical products. The performance of the responsible parties shall also be measured by the achievement of goal-oriented results [7, 9].

##### 4.2 Producer responsibility

Responsibility is one of the most important strategic intents for chemical producers whereby producer management should demonstrate leadership and commitment in driving the adoption and implementation of product stewardship through establishing policy, visions, goals, resources, monitoring and communication systems for the management practices. This is because they have the greatest ability and responsibility to reduce chemical product impacts whereby they have the flexibility to meet these responsibilities by offering their commitment, plan and participation with other stakeholders<sup>8</sup>.

### 4.3 Shared responsibilities

Product stewardship would not be feasible without engaging stakeholders. The responsibilities should be shared among the stakeholders, including employees, suppliers, contract manufacturers, distributors as well as customers. Employees have the responsibility to adhere strictly to the procedures of handling, recycling, use and disposal of chemical products and feedback on the new uses, misuses and adverse effects for inclusion in future chemical product risk characterization. Suppliers have the responsibility to supply information on environment, health and safety, such as chemical safety data sheet as guidance for the chemical products. Contract manufacturers have the responsibility to work closely with the producer to employ appropriate practices of environment, health and safety protection for the operations under contract. Distributors have the responsibility to disseminate appropriate information to chemical product risk, use, handling, recycling, disposal and transmittal to the customers. Customers have the responsibility to use, handle, recycle and dispose chemical products according to the product characteristics to prevent the risks. Producers have the biggest responsibility in the selection of suppliers as well as contract manufacturers to ensure adherence to sound environment, health and safety principles and provide education and appropriate chemical product information to employees, distributors and customers [7, 8].

### 4.4. Financing

To protect from the environment, health and safety implications of a chemical product, product stewardship should include chemical product information, characterization and risk management. Producers need to develop, maintain and distribute chemical safety data sheet for all chemical products with regular updates of regulatory changes, foreseeable exposure and new risks; initiate re-evaluation of risk characterization for new and existing products using environment, health and safety information; develop a product-risk matrix and implement environment, health and safety management action plan including optimum use of energy and natural resources in the design and development of products and processes. All these chemical product lifecycle costs – from using resources, to reducing and managing environment, health and safety risks throughout the processes, should be included with the total product cost. The environment, health and safety costs of chemical product manufacturing, use and end of life management should be minimised, to the greatest extent possible. Producers should thus have a direct financial incentive to redesign their chemical products in order to reduce these costs in product stewardship as a general cost of doing business, through cost internalization or by recovering costs through arrangements with the stakeholders [7, 8].

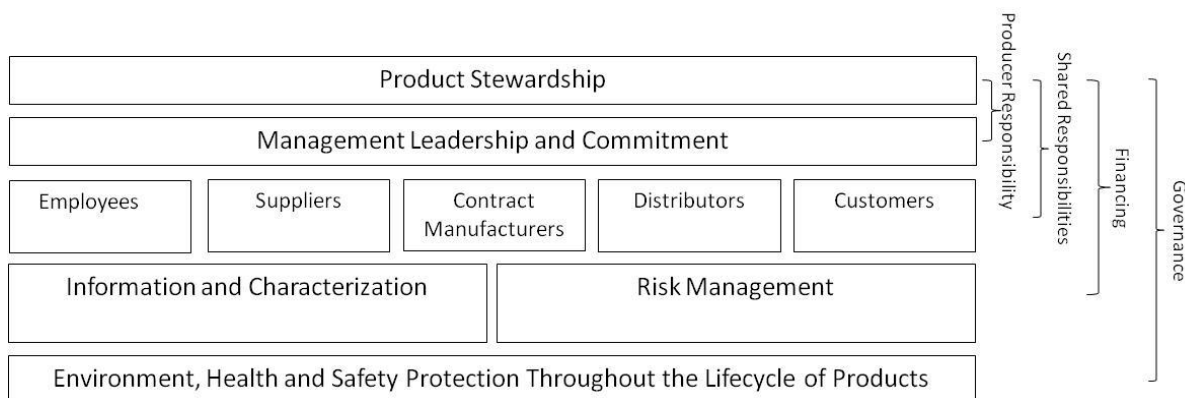


Fig.1. Conceptual framework for the adoption and implementation of product stewardship.

## 5. Conclusion

A conceptual framework has been proposed in this study by incorporating the principles of product stewardship into the management practices. This proposed conceptual framework could be easily adopted and implemented in the chemical industries. The ultimate goal of the product stewardship is to protect environment, health and safety throughout the lifecycle of chemical products. From the governance perspective, producer management should take the responsibility as the driver for the product stewardship adoption and implementation. The responsibility should also be shared with stakeholders, namely employees, suppliers, contract manufacturers, distributors and customers. The financing for product stewardship should be provided for chemicals information, characterization and risk management. Understanding this conceptual framework of product stewardship is crucial to ensuring that product stewardship principles and management practices maintain their integrity and serves as a basis for the development of future tools that could be used to enhance the effectiveness of product stewardship adoption and implementation.

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## References

1. Lee KE, Mokhtar M, Goh CT, Singh H, Chan PW. Initiatives and challenges of a chemical industries council in a developing country: the case of Malaysia. *J Clean Prod* 2015;**86**:417-423.
2. Kubota K, Kamizono A, Miyachi S, Yuki M, Masuda M. Development and verification of new evaluation indicators for chemical management in corporations to meet WSSD goals. *J Clean Prod* 2011;**19**:1134-1140.
3. Leppelt T, Foerstl K, Reuter C, Hartmann E. Sustainability management beyond organizational boundaries – sustainable supplier relationship management in the chemical industry. *J Clean Prod* 2013;**56**,94-102.
4. Lewis H. Defining product stewardship and sustainability in the Australian packaging industry. *Environ Sci Policy* 2005;**8**:45-55.
5. Stitzhal D. Product stewardship: Can it drive green design? *Environ Qual Manage* 2011;Spring,25-41.
6. CICM. *Product stewardship – Code of management practices*. Kuala Lumpur: Chemical Industry Council of Malaysia; 1999.
7. NPSC and CPSC. *Framework principles for product stewardship policy*. Washington. Northwest Product Stewardship Council; 2008.
8. GPSC. *Product stewardship principles and actions*. Turramurra NSW. Global Product Stewardship Council. 2012.
9. Adam G. *10 principles of responsible product stewardship*, 2010. <<http://www.greenbiz.com/blog/2010/07/30/10-principles-responsible-product-stewardship>>