Chapter 4

Possible Impact of the ASEAN Chemical Safety Database

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CHAPTER 4

Possible Impact of the ASEAN Chemical Safety Database

1. Qualitative Impact on the Chemical Management of the Government

Reduction of the testing cost

The largest impact of constructing the Database is probably the reduction of the test costs that can be achieved by data sharing. Whenever governments conduct tests on toxicity to humans, the test results are usually published. However, many of these reports are not written in English, but in local languages, and the information may thus not be sufficiently accessible to interested parties.

For this reason, it is important to construct databases that allow the sharing of results of independently conducted tests in common formats, and displaying the search results in a batch. In order to understand the magnitude of this impact, this report conducted case study analysis for the cost reduction in Section 0.

Reduction of the cost for information gathering

Another potential impact of constructing the Database is a reduction of costs related to information gathering. Whether the toxicity of chemical substances is tested or not is normally decided according to the following procedure: first, the update/maintenance conditions of existing information on toxicity are checked, and then, if the information is found to be insufficient, appropriate tests are conducted. The labor costs required to collect information written in state-of-the-art literature cannot be ignored either.

On the other hand, if each country is able to acquire up-to-date information on toxicity from these databases in the future, much of the cost of collecting information necessary to assign priorities to materials for which detailed risk assessment has to be conducted can be eliminated.

Improve the quality of information for risk assessment

According to the drafted information items of the database described in the previous chapter, the results of risk assessments of each country should also be shared among member countries. This information and collected information on hazards itself could help to improve the basic information used to conduct the risk assessments in each country.

Increasing transparency

The impact of increasing transparency is also an important potential impact of the database. As in the case of testing data, although the regulatory information in each country is basically open to the public, some of the information is not written in English but in local languages.

Therefore, the information item of "regulatory information" could be one of the most important items for enhancing transparency with respect to information disclosure, not only to the domestic firms but also to global firms, foreign policy makers, etc..

Harmonization of regulated chemicals

The cost reduction effects related to testing and information collection described above can in principle be obtained with eChemPortal and other databases as well. However, the databases proposed here have special extra features, in that they provide information on the laws and regulations of each country, along with functions allowing searching and displaying which chemical substances are the targets of relevant regulations in a comprehensive manner. This allows each country to determine the controlled substances of the country, while observing the regulatory conditions of other countries. As a result, it may even be possible to expect that regulations on chemical substances will gradually become harmonized within the ASEAN region.

Convergence of GHS classification result

Moreover, to the possible storage and maintainance of GHS classification results of each country in this Database has also been examined. This would allow each country to compare GHS classification results with other countries. Naturally, the conditions for adopting building blocks of GHS vary from country to country, and it is considered practically impossible to harmonize the classification results completely. However, the database is expected to be of value in cases where the classification results are different from one literature source to another, for example, as it will serve to provide a better foundation for converging on a final classification when reviewing the different classification results.

Improve health outcome

As one of the end outcomes for constructing the database, we can also find a possible contribution to improve health outcomes through more efficient and effective chemical management in all ASEAN and Partner countries.

2. Qualitative Impact on the Chemical Management of the Industry

Reduction of the testing cost/cost of information gathering, Increasing transparency and Convergence of GHS classification result

The features of this impact are much the same as in the previous section on impacts on the "reduction of the testing cost" and "reduction of cost for information gathering," but it is considered separately here because some countries place the burden of test costs on businesses. Please see the previous section for further details.

The "increasing transparency" and "convergence of GHS classification result" could be other positive impacts for the industry.

Reduction of the entry barrier for the SMEs

Data sharing could be one of the most useful functions for SMEs. For example, Multinational companies can obtain information from the global supply chain. On the other hand, SMEs preparing to start exports have technical barriers to gain helpful information.

Because of this inequality, SMEs sometimes face serious entry barriers when they consider entering the market of emerging countries. In this sense, the existence of this database may help SMEs to remove this entry barrier by providing appropriate information to the public.

3. Qualitative Impact on the ASEAN as a Whole

Contribution to the AEC Goal

The ASEAN Economic Community (AEC) shall be the goal of regional economic integration by 2015. AEC envisages the following key characteristics: (a) a single market and production base, (b) a highly competitive economic region, (c) a region of equitable economic development, and (d) a region fully integrated into the global economy.[1]

In this context, this database could contribute to the AEC goal, mainly through its key characteristic (a): a single market and production base. The sequence of impacts written here will contribute to achieving this characteristic. Furthermore, in the context of the AEC area of cooperation, the followings are mentioned; the AEC will transform ASEAN into a region with free movement of goods, services, investment, skilled labor, and freer flow of capital. To achieve the transformation of ASEAN into a region with free movement of goods (especially chemical goods), the construction of this database should be considered absolutely necessary.

[1] http://www.aseansec.org/18757.htm

Harmonization of chemical regulation

Secondly, enhancing the harmonization of chemical regulation in member countries could be one of the major long-term outcomes.

Contribution to the WSSD Target

Last, but not least, the establishment of this database also could contribute to the achievement of the WSSD Target, 2020. Although there would be some discussion as to which part of the WSSD target this database would contribute to, one potential option would be action (a), aiming to promote the ratification and implementation of relevant international instruments on chemicals and hazardous waste, and encouraging and improving its coordination as well as supporting developing countries in their implementation.

Paragraph 23, Chapter 3 of Johannesburg Plan of Implementation, World Summit on Sustainable Development[2]
23. Renew the commitment, as advanced in Agenda 21, to sound management of chemicals throughout their life cycle and of hazardous wastes for sustainable development as well as for the protection of human health and the environment, inter alia, aiming to achieve, by 2020, that chemicals are used and produced in ways that lead to the minimization of significant adverse effects on human health and the environment, using transparent science-based risk assessment procedures and science-based risk management procedures, taking into account the precautionary approach, as set out in principle 15 of the Rio Declaration on Environment and Development, and support developing countries in strengthening their capacity for the sound management of chemicals and hazardous wastes by providing technical and financial assistance. This would include actions at all levels to: (a) Promote the ratification and implementation of relevant international instruments on chemicals and hazardous waste, including the Rotterdam Convention on Prior Informed Consent Procedures for Certain Hazardous Chemicals and Pesticides in International Trade10 so that it can enter into force by 2003 and the Stockholm Convention on Persistent Organic Pollutants11 so that it can enter into force by 2004, and encourage and improve coordination as well as supporting developing countries in their implementation; (b) Further develop a strategic approach to international chemicals management based on the Bahia Declaration and Priorities for Action beyond 2000 of the Intergovernmental Forum on Chemical Safety12 by 2005, and urge that the United Nations Environment Programme, the Intergovernmental Forum, other international organizations dealing with

[2] http://www.un.org/esa/dsd/susdevtopics/sdt_toxichemintegovedeci.shtml#wssd

chemical management and other relevant international organizations and actors closely cooperate in this regard, as appropriate;

(c) Encourage countries to implement the new globally harmonized system for the classification and labelling of chemicals as soon as possible with a view to having the system fully operational by 2008;

(d) Encourage partnerships to promote activities aimed at enhancing environmentally sound management of chemicals and hazardous wastes, implementing multilateral environmental agreements, raising awareness of issues relating to chemicals and hazardous waste and encouraging the collection and use of additional scientific data;

(e) Promote efforts to prevent international illegal trafficking of hazardous chemicals and hazardous wastes and to prevent damage resulting from the transboundary movement and disposal of hazardous wastes in a manner consistent with obligations under relevant international instruments, such as the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal;13

(f) Encourage development of coherent and integrated information on chemicals, such as through national pollutant release and transfer registers;

(g) Promote reduction of the risks posed by heavy metals that are harmful to human health and the environment, including through a review of relevant studies, such as the United Nations Environment Programme global assessment of mercury and its compounds.

In addition to the possible impacts written above, impact of " Facilitation of trade" and "Improvement of health and environmental outcomes" shall also be expected. The former one is rather far outcome through the contribution to the achievement of AEC goal, etc., and the latter one is basically similar to the impact written in 0.

4. Difference between the Impacts of New and Existing Chemicals

Considering the impacts noted in the previous section, the feature of the current chemical management scheme could influence the impact of the database. One feature that causes a significant difference is the difference in treating "existing" and "new" chemicals in the current chemical management structures. As already mentioned in the chapter 2, several countries employ different schemes of management for "existing" and "new" chemicals. Of course, if we try to discuss "existing" and "new" chemicals in ASEAN and Partner countries, there would be practical issues, such as how to define “existing chemicals” in ASEAN and Partner countries, etc.[3] However, it would be worthwhile to consider whether these practical issues could be overcome, and to observe the differing impact of whether a chemical is classified as “existing” and “new.”

Impact on Existing Chemicals

Considering the practical applications, the impact on existing chemicals shall be significant. For example, most of the GHS classifications are conducted for existing chemicals (of cause it depends on the definition, but if we employ the definition mentioned in the footnote of this page), because the quantity of existing chemicals is much larger than that of new chemicals. Therefore, if at least the information set to conduct GHS classification becomes common, this may lead to the further harmonization of GHS classification results in each country.

Impact on New Chemicals

Consider the case that the authority of each country uses information uploaded to the database for their chemical management strategy. The simplest way is to use the information in the approval process for producing/importing the new chemicals. In general cases, the local authority requires businesses to provide necessary information on physical, human health, and environmental hazards of the newly approved chemicals. To reduce the burden of the businesses, information gathered in the database may be useful.

[3] One possible solution toward this issue is to organize a common existing chemicals inventory among member countries. To organize the common inventory, the scheme that the Vietnamese government plans to employ may be useful. The Vietnamese government now plans to organize an inventory of existing chemicals by referring to its own inventory and that of Japan and the United States.

5. Case Study to Identify the Quantitative Impact

5.1. Notice for the Assumptions to Calculate the Quantitative Impact

Before discussing the specific calculation to identify the quantitative impact, several notation on the assumption and result of this impact should be made. First of all, this sequence of analysis is based on the previous report, “Study on the Economic Impact of Chemicals Management in ASEAN and East-Asia” (“previous report” hereafter), and basically we followed all of the basis employed in that report. Therefore, the explanation on the detailed calculation written in the previous report is omitted.

Moreover, among the impacts caused by the introduction of the database discussed by the previous section, the impacts which could be described quantitatively are categorized as the following three: 1) reducing the operational burdens to gather appropriate information by information sharing, 2) reducing the cost to confirm the credibility of data to conduct risk assessment, 3) reducing the testing cost by referring to the tested results which are conducted by other governments, testing facilities.

First of all, the cost by “1) reducing the operational burdens by sharing information” corresponds to the “Registration Cost”, which corresponds to the person-day cost to prepare appropriate dossier for registration by private firms, according to the previous report and “Extended Impact Assessment”.[4] The Registration cost can be divided into the three categories: a) the cost of gathering data, b) the cost of exposure assessment and c) the cost of preparing dossiers. In particular, “a) the cost of gathering data” approximately accounts for 30%,[5] all of which can be cut down on the basis of the assumption that the database sharing sufficient information can be established. Therefore, in case that each country introduced Prioritization-Led Approach by its own, the rough calculation based on the previous report expects the following reduction of cost:

110.4million€×30%＝33.1 million€

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[4] Extended Impact Assessment, Commission of the European Communities, 2003

[5] Exactly, in “Extended Impact Assessment” by the European Commission and its previous report “Revised Business Impact Assessment for the Consultation Document, RPA, 2003”, data gathering cost within registration cost account for 25.7% in case that Full Registration on the chemical substances over 1000t/y is conducted.

Secondly, the cost by “2) reducing the cost to confirm the credibility of data employed in the risk assessment” can be categorized as Agency Fee, which corresponds to the cost to operate an agency (e.g., ECHA), and Restriction Cost, which corresponds to the cost to conduct detailed risk assessment and socio-economic analysis toward restriction, according to the previous report and “Extended Impact Assessment”. On the other hand, it is not obvious to identify what percentage of these cost are spent to confirm the credibility of gathered data. Therefore, in case that each country introduces prioritization-led approach by its own, the rough calculation based on the previous report expects the reduction of the part of following cost:

17.1(Restriction Cost)+182.3(Agency Fee)=199.4 million€

Although the two calculation above can grasp the approximate cost by rough estimation, further elaboration may be difficult. Comparatively, on the other hand, the more detailed calculation about “3) reducing the testing cost” may be possible in case that the amount of duplicated testing substances can be evaluated. Thus, this section hereafter attempts to quantify the impact of “3) reducing the testing cost by referring to the testing results which are held by other individual governments”.

It should be noted to interpret the results of reducing the testing cost. Specifically, it is assumed in this case that each country introduces the prioritization-led approach in the appropriate timeline based on the economic conditions and, moreover, it conducts the tests on the prioritized chemical substances evaluated individually by its own budget.[6] On the other hand, considering the current status of ASEAN countries, it should be questioned whether each country newly conducts human health/ environmental assessment by itself; therefore, the value calculated by this analysis may be overestimated.

However, it must be significant to compare the both of the ideal state (Case 1; all countries employ the prioritization-led approach in the appropriate timeline but do not share information at all, and Case 2; all countries employ the prioritization-led approach in the appropriate timeline and share information completely) and derive policy

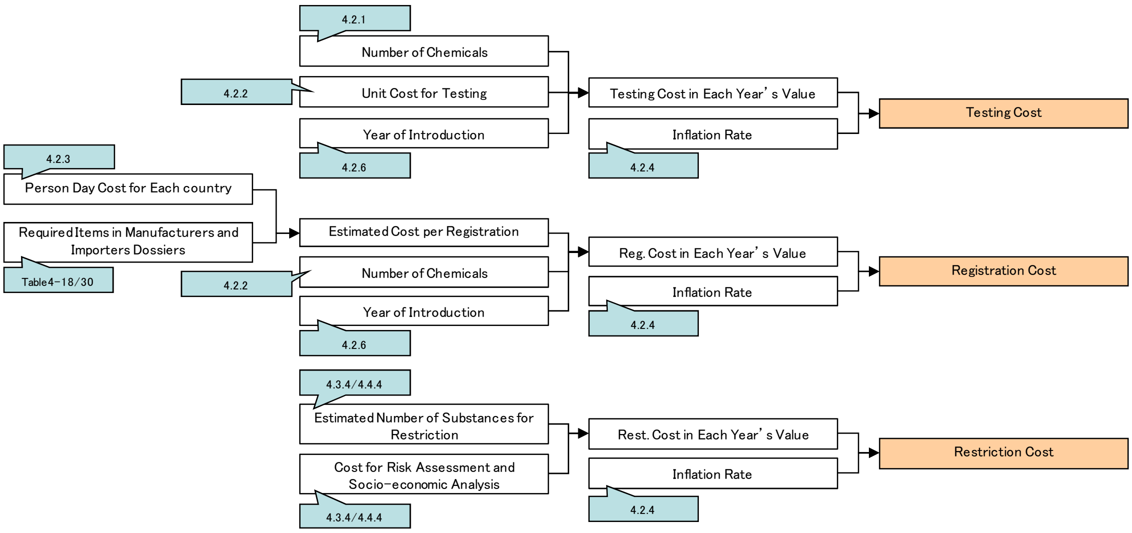
[6] Moreover, it is assumed that the tests are conducted by the laboratories in developed countries due to the lack of laboratories capable of testing in each country. Therefore, unit testing cost is the same as Europe.

implication from the comparison. Therefore, the objective of the following analysis is not to identify the exact value itself but to grasp the rough amplitude of value for comparison.

5.2. Basic Concept of the Calculation

Before estimating the expected reductions in testing costs, the basic concept of the prerequisite cost calculation is briefly explained. First, Figure shows the cost calculation flow of the previous report as a pattern diagram.

Figure 1: Basic Structure of the Calculations in the Previous Report



Source: Study on the Economic Impact of Chemicals Management in ASEAN and East-Asia, ERIA

The testing cost calculation method is described at the top of Figure , but basically, the cost is calculated by the following very simple formula[7].

(Number of chemical substances to be tested) x (unit testing cost)

If complete data sharing via the database etc., is realized, the "Number of chemical substances to be tested" in the simplified formula above is likely to change.

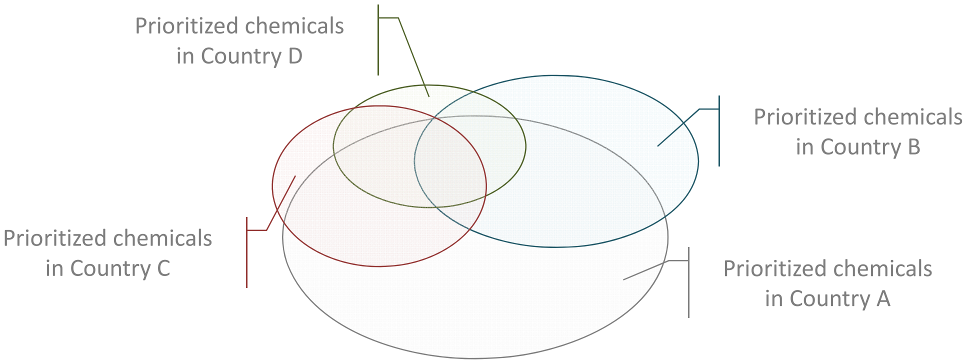
In the analysis in the previous report, a process to eliminate test results that are already available as existing information when conducting tests from the calculation

[7] Note that assumptions regarding when the tests will take to conduct must also be made in an actual calculation, in order to take inflation into account.

was described. This eliminating process draws on the eliminating process employed when the REACH regulation of EU was implemented, and it does not assume that the focus substances to be tested can be selected efficiently, because the relevant information can be shared as each country conducts toxicity tests in parallel.

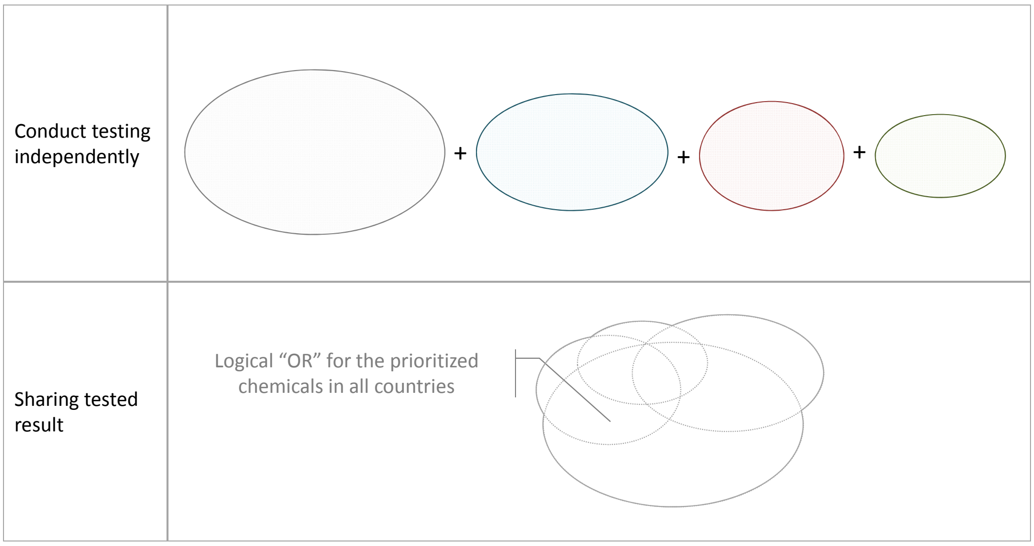
For this reason, in the analysis of this section, we decided to estimate how much the testing costs can be reduced if the relevant information is shared efficiently. Figure 1 is a conceptual drawing, showing how some chemical substances tested in different countries overlap.

Figure 1: Schematic Illustration for the Overlapping of Prioritized Chemicals



For example, when prioritized chemicals in countries A to D are expressed in a Venn diagram, it is likely that the overlapping areas will be quite large, because chemical substances that are considered to represent high risks in different countries are quite alike from the viewpoints of toxicity and/or versatility of usages. If each country conducts independent toxicity tests at a relatively fast pace toward the WSSD target year of 2020 under these conditions, it is considered practically difficult for the countries to share test results appropriately given the time pressure and language differences. Considering how much the cost can change (Figure 2), if each country conducts tests independently, and all the substances covered by circles in the Venn diagram become test focus substances. On the other hand, if each country is able to share sufficient information via the ASEAN database or similar venues, in principle only the chemical substances corresponding to the logical "OR" in the Venn diagram will have to be tested anew.

Figure 2: Basic Concept for the Cost Calculation in Two Cases



5.3. Outline of the Calculation

In order to estimate the overlap of the target chemical substances explained above, it is essentially necessary to calculate the risks of specific chemical substances from the viewpoints of both toxicity (level of hazard) and their amount of usage. Based on the result, we shall consider which chemical substances can be prioritized within each country, and the extent to which they overlap can be identified. However, at this moment, it is not possible to trace the amount of chemical substances in use in each country based on their CAS numbers and compare the toxicity of each chemical substance for all countries at the same time, as this data is simply not available.

For practical calculation purposes, the data available from all countries at the same time includes the trading statistics covered in Chapter 2. In the following chapters, we therefore use the trading statistic data to estimate overlaps of chemical substances explained above approximately, based on the data of the amount of imported chemical substances itemized in the trading statistics.

5.4. Detailed Methodology of the Calculation

As the base of estimation, we used the volume of import (excluding re-import) in the last year for each subdivision of the HS code (285 divisions) in each country under analysis. Since trading statistic data in 2010 was unavailable for some countries, we used the trading statistic data of 2009. The specific calculation procedure is explained in A) to D) as follows.

A) Cross-Country Data Collection of the Imported Volume of Chemicals

First, we made a simple cross-country comparison of the imported volume by chemical substance group (subdivision of HS code), as of 2009. This provides a data table of 12 countries x 285 divisions. We assumed that it is possible to make a quasi-estimation of the approximate volume of production of 285 randomly picked substances in 12 countries. We further assumed that production volume and toxicity are independent (or, independent and identically distributed (IID)).

Although these assumptions are rather far-fetched, they do allow replacing the level of risk with the scale of production volume when information regarding toxicity to humans is not available. Therefore, in the subsequent analysis, we proceeded by replacing substances with high environmental risk in relevant countries as substances with high production volume for modeling purposes.

B) Assumption on the Rate of the Prioritized Chemicals among General Chemicals

Next, we considered the ratio of substances specified as Priority Assessment Chemical Substances among the 285 “virtual” substances we assumed to be randomly picked. In this analysis, we changed this ratio to make estimations in order to minimize errors. On the other hand, as explained in the report published last year, the number of Priority Assessment Chemical Substances depends on the quantity of chemical substances consumed in a country. For this reason, we used the number of Priority Assessment Chemical Substances in China, which was the greatest number encountered in the report last year, as the basis, and normalized the number of Priority Assessment Chemical Substances from the maximum figure of 285 for China to the minimum figure of 1, to express the changes of degree of overlap in as generic terms as possible.

The numbers of Priority Assessment Chemical Substances in countries other than China were then set to be proportional to the number of Priority Assessment Chemical Substances in each country reported last year. For example, in the last year’s report, the number of Priority Assessment Chemical Substances in China was 5271, while the number in Japan was 2000. Then, if 100 substances out of the 285 “virtual” substances are specified as Priority Assessment Chemical Substances in China, we calculated that 108 substances are specified as Priority Assessment Chemical Substances in Japan (285 x 2000 / 5271).

C) Calculation of the Number of Prioritized Chemicals in each Country

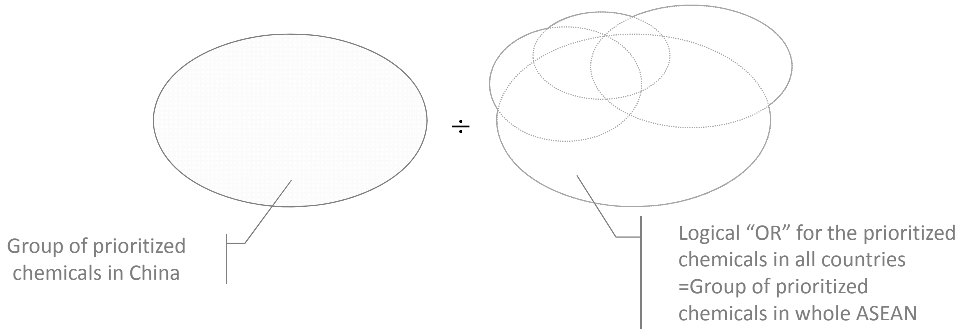
Next, we determined which substances of the 285 “virtual” substances are specified as Priority Assessment Chemical Substances for each country. Here, since the toxicity and production volume of substances are assumed to be independent, as explained earlier, it is expected that, the larger the production volume, the higher the environmental risk. Here, we took the number of Priority Assessment Chemical Substances set in the previous report, and the ratio of Priority Assessment Chemical Substances set in the previous section, into consideration to determine which substances of the 285 “virtual” substances should be specified as Priority Assessment Chemical Substances.

Specifically, we assumed that, if 5 substances are specified as Priority Assessment Chemical Substances in a certain country, the 5 substances with the greatest production volume (replacing volume of import) are specified as Priority Assessment Chemical Substances.

D) Calculation of the Rate of Overlapping in Prioritized Chemicals across Countries

Based on the table of priority assessment substances of each country we assumed in the previous section, we evaluate the ratio of overlap among prioritized chemicals when the prioritization-led approach is introduced to each country. Specifically, we calculated how many percentages the number of prioritized chemicals in China, which was estimated to be the largest, represents out of the total number of prioritized chemicals in all of the ASEAN countries.

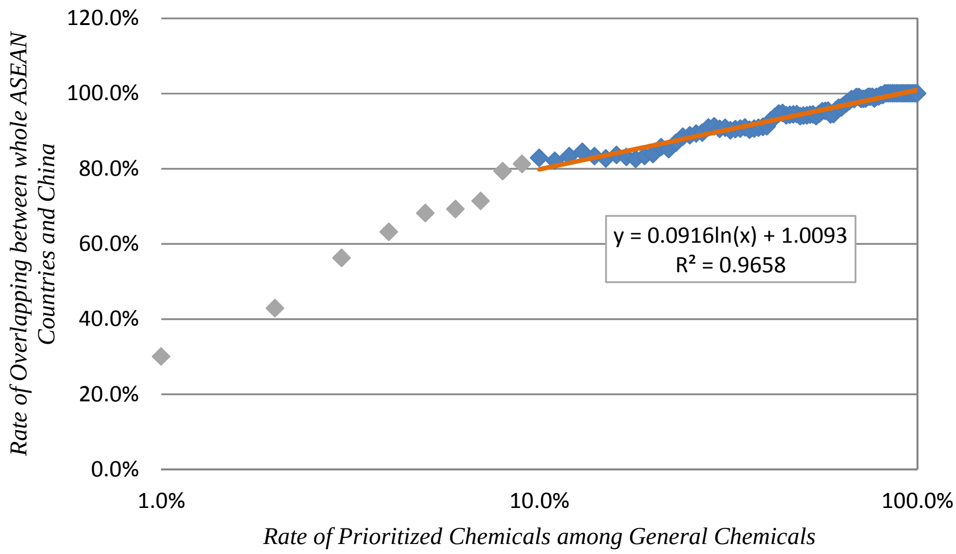
Figure 3: Concept for calculating a rate of overlap between the whole of ASEAN+6 and China



5.5. Calculation Result

The results of our calculations using the procedure above are shown below. Figure 4 shows the results by plotting the ratio of prioritized chemicals to all target substances, determined in B) above, along the X axis, and the variable determined in D) above (assuming the number of prioritized chemicals in entire ASEAN is set to 100, how great a percentage does the number of prioritized chemicals in China, which is the largest among all the countries, cover?), along the Y axis, respectively.

Figure 4: Relation between Rate of Overlap and Rate of Prioritized Chemicals



As is clear from the assumptions, if the ratio of prioritized chemicals is 100% (all chemical substances are specified as prioritized chemicals), all 285 substances under study would this time be specified as prioritized chemicals. The result of calculation of the Chinese case only, and the result of taking the union (logical “OR”) of all target countries of ASEAN+6, would represent the same set.

When the ratio of prioritized chemicals is lowered, the selection of chemical substances produced is large volume in China, but not in other countries, and vice versa, it becomes more relevant. As a result, the unions (logical “OR”) of prioritized chemicals of ASEAN countries and prioritized chemicals in China start to differ. Looking at how this difference changes, a strong linear correlation can be seen between the logarithm of the ratio of overlapping, and the ratio of prioritized chemicals.

Next, before proceeding to the subsequent actual estimations, we examine the percentage of chemical substances that are specified as prioritized chemicals out of all chemical substances. Indeed, if the number of existing chemical substances is set as a population parameter, the number of chemical substances with a CAS No. assigned exceeds 100 million. However, since the scope of the target of this system is limited to industrial chemicals, it is not considered appropriate to include chemical substances that are hardly used in the industrial world when calculating the population parameters.

In the analysis in the previous report, we similarly estimated the number of chemical substances whose transaction volume in each country is 1 ton or larger, for the purpose of calculating the costs involved in No-data and No-market Approach. We have thus also decided to make use of that result in this analysis, and set chemical substances with a transaction volume of 1 ton or larger as the parent population of this analysis. In the analysis in the previous report, the percentage of chemical substances specified as prioritized chemicals among those whose transaction volume is 1 ton or larger was found to be 17.3%. For this reason, in the subsequent estimations, 17.3% of all chemical substances are assumed to be specified as Priority Assessment Chemical Substances, among which 25% are subjected to toxicity tests.[8] Thus, information regarding 4.3% of the commonly used chemical substances (17.3% x 25% = 4.3%) should be shared in the industrial circles. The degree of overlap between ASEAN as a whole and China is calculated under these assumptions by setting x in the following estimation formula to 0.043 (=4.3%) as explained in Figure 4:

$$y = 0.0916\ln(x) + 1.0093$$

[8] According to the assumptions written on page 174 of the previous report.

Using the ratio calculated here, we estimated the number of prioritized chemicals corresponding to the logical “OR” in the union of all of the ASEAN countries using the approach outlined in Figure 2, and found it to be 7306 substances. We thus distributed this number of chemical substances, according to the ratio of number of prioritized chemicals originally set for each country, and estimated the number of target substances to be tested when data is fully shared.

Table 1: Number of Prioritized Chemicals in Two Cases

	Conducting Test Independently	Sharing the Test Results
Australia	108	67
Japan	2000	1229
Singapore	296	182
New Zealand	11	7
Korea	1807	1111
Malaysia	315	194
Thailand	691	425
China	5271	3239
Indonesia	342	211
Philippines	37	23
Vietnam	71	44
India	944	580

Based on this result, we conducted exactly the same testing cost analysis as in the previous report. Table 2 shows the results. According to this analysis, the reduction of testing costs achieved by effective data sharing is €571.5 million (around 770 million US dollar), which is a very significant amount.

Table 2: Comparison of Testing Cost between the Two Cases

(€ million)

	Conducting Test Independently	Sharing the Test Results	Amount of Cost Reduction
Australia	12.5	7.8	4.8
Japan	298.6	183.5	115.1
Singapore	40.2	24.7	15.5
New Zealand	1.3	0.8	0.5
Korea	232.9	143.2	89.7
Malaysia	34.2	21.1	13.2
Thailand	75.1	46.2	28.9
China	679.3	417.4	261.9
Indonesia	25.0	15.4	9.6
Philippines	3.4	2.1	1.3
Viet Nam	6.1	3.8	2.3
India	74.7	45.9	28.8
Total	1,483.4	911.9	571.5

APPENDIX

Scale Independence

At the end of this chapter, we briefly examine the scale independency of this analysis as an addendum to this study. We conducted this analysis using data of groups of 285 substances in the trading statistics as the basis. One of the issues of this information source is that the data is not about individual substances, but about groups of substances. For this reason, we consider the appropriateness of handling data of substance groups based on the estimations made above.

The basic idea for consideration here is as follows. Since it is impossible to further subdivide data of the groups of 285 substances, we conducted similar analysis on the major and medium division data, rather than the groups of 285 substances, which are of minor division data, and examined the robustness of our results.

Figure APX-1 shows the results of the analysis explained above, repeated for varying degrees of roughness for each substance group. As can be seen from the graph, the trends are generally identical, except in the low percentage range, where the statistical errors become more significant. Almost the same result was obtained by actual fitting. For this reason, it is safe to consider that this analysis method guarantees a certain level of robustness, regardless of the roughness of dividing substances into groups. Thus, it can be concluded that the result of this analysis is likely to be approximately the same as the result for the analysis of all target chemical substances.

Figure APX-1: Difference from the Segment Roughness