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WORKING PAPER 10/2014

A proposed methodology for the sustainable assessment of industrial subsectors for policy advice

INCLUSIVE AND SUSTAINABLE INDUSTRIAL DEVELOPMENT

RESEARCH, STATISTICS AND INDUSTRIAL POLICY BRANCH
WORKING PAPER 10/2014

A proposed methodology for the sustainable assessment of industrial subsectors for policy advice

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1. Introduction

1.1 Overall introduction

"Manufacturing" as the engine of growth is a commonly used slogan in favour of manufacturing. In his most recent book, the internationally acclaimed Cambridge economist Ha-Joon Chang devotes one full section to the importance of manufacturing for economic growth (Chang, 2007). Chang claims: *"History has repeatedly shown that the single most important thing that distinguishes rich countries from poor ones is basically their higher capabilities in manufacturing, where productivity is generally higher, and, most importantly, where productivity tends to (although does not always) grow faster than in agriculture and services"* (Chang, 2007: 213). Hence, the case for industrial policy remains strong and is in fact becoming stronger with technical change and globalization (Lall, 2003) to attain the full growth potential of the manufacturing sector in any country.

Industrial development depends on the international context, which is changing rapidly, driven by globalization, liberalization and technological change. Specifically, it is characterized by tighter linkages within global value chains based on close coordination between national and international actors within integrated systems. The success of national industries thus increasingly depends on countries' ability to be active in industries that are dynamic, fast growing and have high returns. On the other hand, the national context also matters. On the supply side, the fundamental changes that occur in any economy can be associated to a large degree with the changes in the country's factor endowment which entails differences among countries in terms of labour and capital endowments. At the static level, this notion implies that any country must align its productive capacities and labour with its current endowment structures. At the dynamic level, this notion suggests that countries, which excel in the production of goods and services that are in line with their endowment, can accumulate capital and knowledge and thereby change their endowment structures.

Although the significance of the manufacturing industry is widely accepted, the understanding of the manufacturing industry as depicted in existing studies is often fragmented. For example, some studies only deal with economic development and strategy for manufacturing, while other research focuses on environmental analysis. Accordingly, a wider and more holistic view of economic, environmental and social dimensions is needed to design better comparative industry strategies. Specifically, to develop better national manufacturing strategies in the context of 21st century industrial policy (including industrial sustainability), understanding economic, environmental and social developments is crucial. The countries of the ASEAN region require a strategic view of industrial development based on an understanding of all economic, environmental and social conditions. However, few methodologies present a holistic view of industrial sustainability at the level of individual manufacturing industries. This absence of a sophisticated methodology to examine manufacturing industries generates a lack of understanding of the current situation at the level of each industry. This lack of a clear and current perspective impedes the development of a national industrial sustainability plan for a given industry.

The aim of this report is to propose a method for the analysis of the economic dimension as well as of environmental and social aspects, and to demonstrate how an integrated assessment combining these separate analyses can be conducted. Finally, this report concludes with recommendations for each manufacturing industry based on the synthesis of economic, environmental and social results.

1.2 Prospects for AEC formation and the industry sector

Founded in 1967, the Association of Southeast Asian Nations (ASEAN) strives to promote economic and political cooperation between member countries in East Asia, and at the same time facilitates its members' interaction with the rest of the world. Following the Bali Concord II in 2003, the formation of an ASEAN Economic Community (AEC) was determined as the end-goal of regional economic integration. Transforming ASEAN into a single market and production base by 2015 and achieving the free movement of goods, services, investment, skilled labour and freer flow of capital within the region lies at the heart of this AEC concept.

The formation of AEC opens up a plethora of opportunities and challenges for the industrial sectors. Some of these are listed in this section:

- The most obvious opportunity is an enhanced market comprising over 600 million people. Over the period 1998-2012, the ASEAN's average economic growth was 5.9 percent, which exceeds most of that of other regional blocks, signifying an expanding purchasing power of this market.

- Cheaper raw materials: Most industrial sectors can tap into cheaper raw materials stocks that exist elsewhere in the AEC. ASEAN is rich in natural resources, for instance, ASEAN holds over 40 percent of the oil and gas resources of the Asia-Pacific. This, too, will enable industries to find cheaper and consistent supplies of resources.

- Reduction in production costs: In addition to cheaper raw materials, industries can further reduce their costs through improved logistics and a reduction in tariffs and bureaucracy. A McKinsey Research Report[1] finds that firms can cut up to 20 percent of their costs with the establishment of AEC. The report also finds scope for similar cost reductions in other industries as well.

- Increased competition: with the formation of AEC, all industrial sectors must brace themselves for more competition. Firms not only have to compete with their counterparts in other ASEAN economies, but with foreign counterparts as well, as the establishment of AEC will make the region a more lucrative market.

- Increased flow of foreign investments: Charumanee (2012) believes that the formation of AEC will result in increased flows of foreign investments to the region. This will definitely have an impact on the region's industrial landscape.

The former Secretary General of the ASEAN[2] correctly identifies its three strengths 'We (ASEAN) have abundant natural resources in our region. We have large supplies of professionals and talented people. And, we have the capability to adopt, adapt and advance technology.' Effective industrial policy is required to capitalize on these strengths and adapt to the opportunities and challenges AEC poses. This includes, but is not limited to, improving hard and soft infrastructure to reduce logistical barriers, providing capacity building of domestic firms, channelling skills development to cater to the industries and creating opportunities for those rendered unemployed due to increased competition. In this report, we provide certain guidelines on such policy measures, particularly to ensure sustainability of the ASEAN industrialization strategy.

1.3 Structure of the methodology report

The next section of this report, Section 2, expounds an economic analysis and examines data. Section 3 puts forward a method for both environmental and social analyses. Finally, Section 4 shows how to construct a synthetic analysis based on the results of the economic, environmental and social analyses, and provides recommendations for each synthetic conclusion.

The proposed methodology has been adjusted to reflect the situation of local manufacturing industries and to compensate for any lack of available data. Further, the methodology developed in this report provides useful information concerning the integration of sustainability into industrial analysis. For example, sector to sector inter-connectedness is useful in increasing the influence of industrial policy on highly interdependent sectors. More detailed discussion of the

[1] McKinsey (2004).

[2] Remarks by H.E. Ong Keng Yong, Secretary General of ASEAN, at the ASEAN Gala Dinner, London, 4 December 2006.

application of the methodology used in this report can be found in two industrial reports: ‘Chemicals Report in the ASEAN Region’ and ‘Metals Report in the ASEAN Region’.

2. Economic analysis

2.1 Conceptual framework

To design effective industrial policies, it is highly relevant for governments in developing countries to understand their competitive position in comparison to other countries and the rest of the world, given the current domestic and global demand trends. It is equally important to understand which domestic factors and conditions influence this competitive position. Such analysis benefits not only governments, but the private sector, too, as it provides the information on which strategic decisions can be based.

Global integration through international trade and flow of capital are the cornerstones of modern economics. If an economy is to become competitive and to develop further, it will need to actively engage in trade with other economies – very few economies can rely on catering to their domestic markets only. This means that it is important for a country to identify products and industries that are:

- in line with its current endowment structures,
- growing dynamically across the globe due to current and future consumption trends.

The former denotes the supply side of our analysis, i.e. what the country’s core competencies are, and the latter represents the demand side, i.e. whether there is a growing market for the products of specific industries.

Understanding the supply side constraints relates to understanding a country’s comparative advantage as defined by its endowment structure. According to the former chief economist of the World Bank, Justin Lin, a country’s factor endowment entails differences among countries in terms of their labour and capital endowments as well as the country’s ability to create the necessary capabilities given those endowments (Lin, 2011, Lin, 2012). These, in turn, determine what countries are able to produce. His theory builds on an integrated approach which emphasizes the role of markets for resource allocation on the one side, and the government’s role in actively coordinating investments for industrial upgrading and diversification, on the other, and in compensating for externalities generated by first movers in the dynamic growth process.

One cannot look at the supply side of the coin separately and continue to produce goods that are declining in terms of demand. Demand is driven by international and domestic markets. Some industries, like food and beverages and construction materials, are inherently more geared towards demand on the domestic market, while others primarily target the international market. Products are increasingly becoming more complex and reliant on intermediate goods which in turn depend on further intermediate goods. The result is that the production of final products is increasingly becoming intrinsically linked to the degree of their reliance on intermediate goods along the supply chain. Consumption patterns and, therefore, demand, whether domestic or international, affect the growth of industries that produce the final goods as well as those that produce intermediate goods. The entire value chain is affected by consumption which calls for an economy to identify the growing industries in terms of international and domestic demand for both final goods as well as intermediate ones.

Consolidating these two aspects to develop a sound approach to select such industries is not an easy task, but may be paramount for a country to attain successful structural transformation from poorly performing industries to dynamic ones, which generate high value added and provide sufficient employment opportunities without damaging the environment.[3]

This raises the following questions:

- **On the demand side:** Which industries are growing dynamically at the global level? How much weight do a country's globally growing industries carry and how has the country's position changed compared with a decade ago? Can these industries also cater to domestic demand?

- **On the supply side:** Are these industries in line with the country's comparative advantage and endowment structure? Does the development of selected industries guarantee positive spillovers to other industries through supply linkages?

These two aspects form the basis of the analytical framework presented in this report.

2.2 Methodological considerations

Some important methodological considerations need to be outlined:

- *Macro and industrial analysis.* Macro analysis provides a general overview of a country's industrial competitiveness vis-à-vis other countries. By using UNIDO's methodology, the

[3] At UNIDO, this approach is referred to as the "3 E's" namely "Economy, Employment and Environment".

report combines macro with industrial analysis, enabling policymakers to establish realistic and applied parameters. The depth of industrial analysis depends on various factors, including data availability and the objective of the study. The report analyses industrial performance at the 2-digit level in SITC revision 3 and ISIC revision 3.

- *Analysis of levels and trends of relevant indicators.* The report assesses countries' industrial performance as well as the overall trends for a specific period using both internally as well as externally developed indicators. Some of these indicators can be analysed as standalone indicators or as a combination of several indicators, and thus provide an effective way to analyse global industrial trends and countries' competitive position in relation to those trends.

- *Use of quantitative and transparent data.* This report does not rely on business perceptions to assess countries' industrial competitiveness. Notwithstanding their usefulness, perception-based surveys generate partial indicators for inter-country comparisons, as individuals' and companies' views are shaped not only by objective conditions, but by subjective and context sensitive factors as well. UNIDO's methodology relies on a number of carefully selected objectives, outcome-based indicators published by international organizations. Although quantitative indicators will never be perfect proxies of what they intend to measure, they provide a solid foundation for inter-country analyses.

    1. *Value added data.* Value added is defined as the return to factors of production. It is the difference between total output and the total operating costs incurred in the production of goods where total operating cost refers to the sum of total materials and operating cost. This data can be obtained from INDSTAT. The major limitation of INDSTAT is limited industry, country and year coverage. There might be a number of missing data for a given country for certain years in a selected industry. Another limitation of the INDSTAT data relates to the fact that some countries report data as a combination of two or more 2-digit ISIC categories, requiring us to aggregate the data, which can lead to the loss of relevant information we would otherwise obtain at a more disaggregated level. Moreover, for the 2-digit ISIC categories, the source of value added data are industrial surveys which only include a representative subset of all the firms operating within that industry.

    2. *Export data*. Export data was obtained from UN COMTRADE and covers international trade data. It is extensive in terms of product, industry, country and time coverage. The data can therefore provide us with a detailed overview of trade

patterns at a global and country level for a selected industry or product. There are two crucial limitations to UN COMTRADE data. Firstly, data are in nominal terms; this means that data are not adjusted for inflation, and they might therefore show a distorted picture in terms of actual trade performance, which could either be underestimated or overestimated, depending on the country in question. The second limitation is that all trade data are output data; this means that we cannot determine the true value addition of a country's trade performance, as we are also accounting for intermediate input, which covers: (a) value of materials and supplies for production (including cost of all fuel and purchased electricity); and (b) cost of industrial services received (mainly payments for contract and commission work as well as repair and maintenance work).

3. *Input-output tables*. Input-output tables capture the most important financial transactions between different industries and consumers within an economy. They provide an overview of the whole economy along the production and supply chain to intermediate and final use. Input-output tables can be obtained at the national and international level. In this paper, we use input-output tables at the international level. One of the major limitations of input-output tables is that they are disaggregated at the industry level and not at the product level, which can lead to the omission of some of the most important interdependencies.

2.3 Economic assessment

2.3.1 Analysis of exports

An industry's competitiveness can be assessed by analysing its world export share along with its international dynamism and demand for the product (measured by the annual growth of the product in world markets). The analysis of export dynamism is one of the most important factors in the selection of a competitive industry as it enables us to identify the most dynamic exports in the world in a particular period. Our analysis covers a period of 11 years, from 2000 to 2011. The key question we seek to answer here is how the industry's growth compares with the manufacturing average. We calculate the compound annual growth rate (CAGR) of exports and manufacturing as a whole using the following formula:

$$CAGR_i(y_2 - y_1) = \left(\frac{ex_i(y_2)}{ex_i(y_1)}\right)^{\frac{1}{y_2 - y_1}} - 1$$

$ex_i(y_k)$ is the export of industry *i* in year y_k.

From this analysis, we can determine whether an industry in a given country is growing faster or slower than the manufacturing average. Industries that are growing faster than average manufacturing exports are considered to be dynamic, while those that grow slower than the average are considered static.

The share of a country's manufactured exports is then calculated for the period 2000 to 2011 in order to measure the country's impact on world demand for products of that particular industry according to the following formula:

$$WSHARE_{c,i}(y_t) = \frac{ex_{c,i}(y_t)}{ex_{w,i}(y_t)}$$

$ex_{c,i}(y_t)$ is the export of industry *i* from country c in year *t*, $ex_{w,i}(y_t)$ is total world export of industry *i*.

A country's share of exports in world exports of a particular industry gives us a country's competitive position relative to others in international markets. Gains in world market share reflect improved competitiveness, while losses denote a deterioration of the country's competitive position. The change in share between two different years is calculated as:

$$\Delta WSHARE_i = WSHARE_{c,i}(y_2) - WSHARE_{c,i}(y_1)$$

The data used here is based on exports, which we obtain from UN COMTRADE. Two sets of data are required:

1. Exports of all countries to the rest of the world. Here we use ISIC (International Standard Industrial Classification) to obtain data on exports of 22 manufacturing industries. The ISIC classification is based on revision 3 with the harmonized system 1996 (see Annex, Table 1).

2. Exports of a selected economy to the rest of the world. The classification system used is the same as in point 1 above. The example of extracted data for Thailand can be found in the Annex, Table 2.

To calculate the compound annual growth rate (CAGR), we use data from Table 1 in the Annex, where 2000 is the initial year and 2011 the final year. We calculate the growth rates using formula 1 for all manufacturing industries and total manufacturing (given in Table 1). Depending on whether the growth rates of a particular manufacturing industry are above or below the manufacturing sector's total average growth, we label an industry as being either dynamic or static.

Table 1 Manufacturing exports – growth rates for the whole world

Product Code	Product Description	Reporter Name	Partner Name	World Annual Growth Rate	World Dynamism
15	Manufacture of food products and beverages	All countries	World	9.59%	Dynamic
16	Manufacture of tobacco products	All countries	World	2.89%	Static
17	Manufacture of textiles	All countries	World	5.74%	Static
18	Manufacture of wearing; dressing and dyeing of fur	All countries	World	5.86%	Static
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	All countries	World	7.95%	Static
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	All countries	World	4.10%	Static
21	Manufacture of paper and paper products	All countries	World	4.72%	Static
22	Publishing, printing and reproduction of recorded media	All countries	World	3.67%	Static
23	Manufacture of coke, refined petroleum products and nuclear fuel	All countries	World	15.81%	Dynamic
24	Manufacture of chemicals and chemical products	All countries	World	10.15%	Dynamic
25	Manufacture of rubber and plastic products	All countries	World	9.60%	Dynamic
26	Manufacture of other non-metallic mineral products	All countries	World	7.08%	Static
27	Manufacture of basic metals	All countries	World	12.43%	Dynamic
28	Manufacture of fabricated metal products, except machinery and equipment	All countries	World	8.98%	Dynamic
29	Manufacture of machinery and equipment N.E.C.	All countries	World	9.28%	Dynamic
30	Manufacture of office, accounting and computing machinery	All countries	World	1.37%	Static
31	Manufacture of electrical machinery and apparatus N.E.C.	All countries	World	8.34%	Dynamic
32	Manufacture of radio, television and communication equipment and apparatus	All countries	World	4.77%	Static

33	Manufacture of medical, precision and optical instruments, watches and clocks	All countries	World	9.36%	Dynamic
34	Manufacture of motor vehicles, trailers and semi-trailers	All countries	World	6.86%	Static
35	Manufacture of other transport equipment	All countries	World	6.98%	Static
36	Manufacture of furniture; manufacturing N.E.C	All countries	World	7.83%	Static
	TOTAL MANUFACTURING	All countries	World	8.16%	

To calculate the share of exports of the selected ASEAN economy (in this case, Thailand), world exports of a manufacturing industry (analysis of impact) and the changes in the shares for the period 2000 – 2011, we use the export data of Tables 1 and 2. For each respective year, the value of the country's exports (Annex, Table 2) in the manufacturing industries is divided by the world total (Annex, Table 1). Thereby, we obtain the shares and calculate changes in shares to determine how much a country is gaining or losing in terms of world impact (Table 2).

Table 2 Exports – changes in shares

				Share in world exports		
Product Code	**Product Description**	**Reporter Name**	**Partner Name**	**2000**	**2011**	**Industrial Export Perfor-mance**
15	Manufacture of food products and beverages	Thailand	World	3.47%	4.06%	Gain
16	Manufacture of tobacco products	Thailand	World	0.08%	0.08%	Loss
17	Manufacture of textiles	Thailand	World	1.46%	1.42%	Loss
18	Manufacture of wearing apparel; dressing and dyeing of fur	Thailand	World	2.17%	1.08%	Loss
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	Thailand	World	2.64%	1.19%	Loss
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	Thailand	World	0.97%	2.19%	Gain

21	Manufacture of paper and paper products	Thailand	World	0.65%	1.55%	Gain
22	Publishing, printing and reproduction of recorded media	Thailand	World	0.13%	6.07%	Gain
23	Manufacture of coke, refined petroleum products and nuclear fuel	Thailand	World	1.12%	1.43%	Gain
24	Manufacture of chemicals and chemical products	Thailand	World	0.80%	1.46%	Gain
25	Manufacture of rubber and plastic products	Thailand	World	1.47%	3.22%	Gain
26	Manufacture of other non-metallic mineral products	Thailand	World	1.65%	1.61%	Loss
27	Manufacture of basic metals	Thailand	World	0.50%	1.03%	Gain
28	Manufacture of fabricated metal products, except machinery and equipment	Thailand	World	0.91%	1.63%	Gain
29	Manufacture of machinery and equipment N.E.C.	Thailand	World	0.70%	1.35%	Gain
30	Manufacture of office, accounting and computing machinery	Thailand	World	2.72%	4.09%	Gain
31	Manufacture of electrical machinery and apparatus N.E.C.	Thailand	World	1.55%	1.66%	Gain
32	Manufacture of radio, television and communication equipment and apparatus	Thailand	World	1.98%	2.07%	Gain
33	Manufacture of medical, precision and optical instruments, watches and clocks	Thailand	World	0.61%	0.92%	Gain
34	Manufacture of motor vehicles, trailers and semi-trailers	Thailand	World	0.42%	1.56%	Gain
35	Manufacture of other transport equipment	Thailand	World	0.24%	1.17%	Gain
36	Manufacture of furniture; manufacturing N.E.C	Thailand	World	2.06%	2.36%	Gain

Based on the above export analysis, we are able to classify industries into the following four categories:

Champions: a champion export is a highly dynamic product — growing above the world exports' average — with a world market share gain. Successful exporters tend to have an important number of champion exports, reflecting a country's ability to gain world market share in the most dynamic and demanded products;

Underachievers: these exports are highly dynamic in world markets, but the country is losing world market share. Such exports are considered 'lost opportunities' as the country is failing to compete in fast growing products;

Champions in Adversity: overachiever exports are not very dynamic products — they grow below the world exports' average — and yet the country is gaining world market share. This tends to be a common feature of many resource-rich developing countries as their major exports record sluggish growth in world demand;

Decline: products from this group are slow growing exports in world markets where the country is losing world market share. It must be noted that it is not necessarily a bad sign for the country to have declining exports if they are balanced by champion exports. This is indeed a feature of many industrialized countries that lose competitive edge in slow growing, labour-intensive exports while strengthening the position of high value added and technology intensive exports.

Based on the results calculated in Tables 3 and 4, we can provide the following categorization of industries into champions, champions in adversity, declining and underachievers (Table 3).

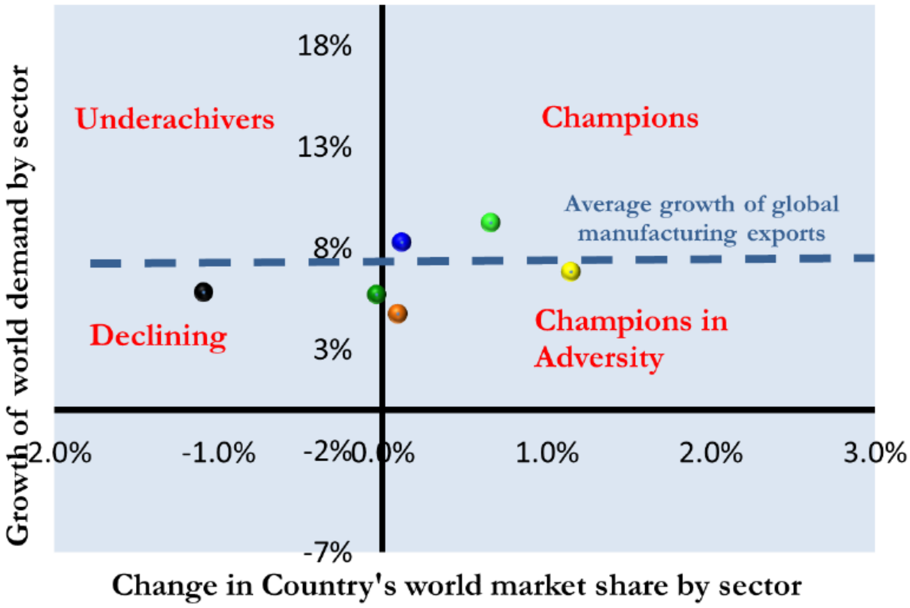
Table 3 Categorization based on export performance and world export demand

Product Code	Product Name	Reporter Name	Partner Name	World Dynamism	Industrial Performance	Classifi-cation
15	Manufacture of food products and beverages	Thailand	World	Dynamic	Gain	Champion
16	Manufacture of tobacco products	Thailand	World	Static	Loss	Declining
17	Manufacture of textiles	Thailand	World	Static	Loss	Declining
18	Manufacture of wearing apparel; dressing and dyeing of fur	Thailand	World	Static	Loss	Declining
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	Thailand	World	Static	Loss	Declining
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	Thailand	World	Static	Gain	Champion in Adversity
21	Manufacture of paper and paper products	Thailand	World	Static	Gain	Champion in Adversity
22	Publishing, printing and reproduction of recorded media	Thailand	World	Static	Gain	Champion in Adversity
23	Manufacture of coke, refined petroleum products and nuclear fuel	Thailand	World	Dynamic	Gain	Champion
24	Manufacture of chemicals and chemical products	Thailand	World	Dynamic	Gain	Champion
25	Manufacture of rubber and plastic products	Thailand	World	Dynamic	Gain	Champion

26	Manufacture of other non-metallic mineral products	Thailand	World	Static	Loss	Declining
27	Manufacture of basic metals	Thailand	World	Dynamic	Gain	Champion
28	Manufacture of fabricated metal products, except machinery and equipment	Thailand	World	Dynamic	Gain	Champion
29	Manufacture of machinery and equipment N.E.C.	Thailand	World	Dynamic	Gain	Champion
30	Manufacture of office, accounting and computing machinery	Thailand	World	Static	Gain	Champion in Adversity
31	Manufacture of electrical machinery and apparatus N.E.C	Thailand	World	Dynamic	Gain	Champion
32	Manufacture of radio, television and communication equipment and apparatus	Thailand	World	Static	Gain	Champion in Adversity
33	Manufacture of medical, precision and optical instruments, watches and clocks	Thailand	World	Dynamic	Gain	Champion
34	Manufacture of motor vehicles, trailers and semi-trailers	Thailand	World	Static	Gain	Champion in Adversity
35	Manufacture of other transport equipment	Thailand	World	Static	Gain	Champion in Adversity
36	Manufacture of furniture; manufacturing N.E.C	Thailand	World	Static	Gain	Champion in Adversity

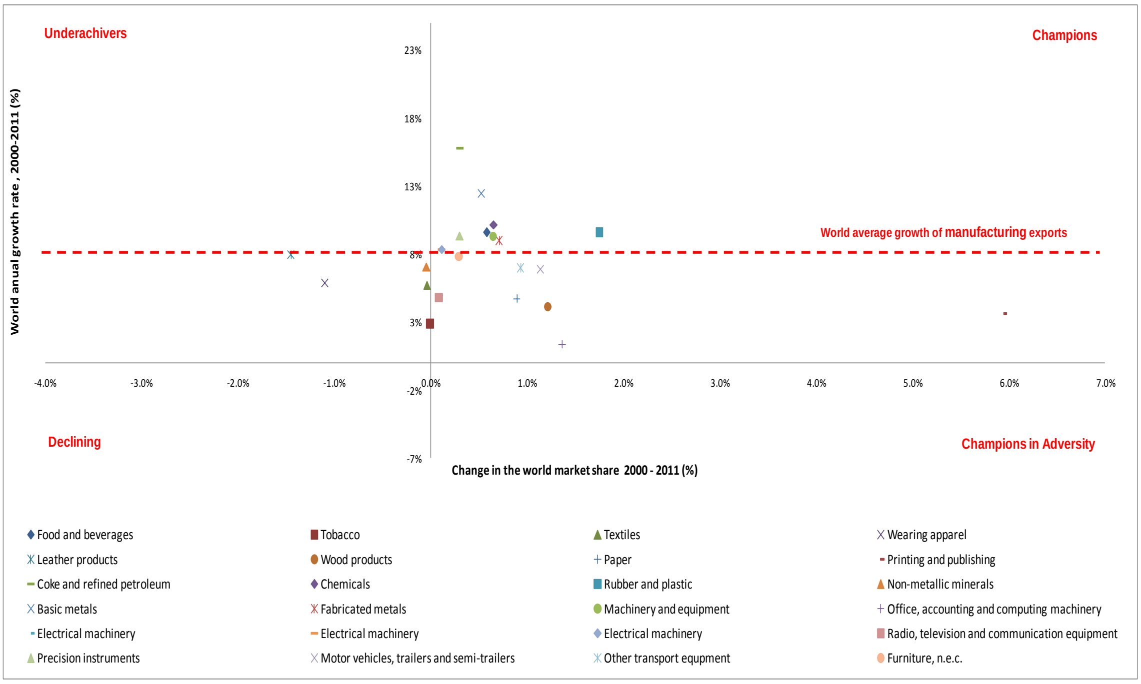
To simplify the analysis, we compile the data of the above table into a graph, carefully demarcating which manufacturing industries fall into the four categories (i.e., Champions, Underachievers, Declining and Champions in Adversity), the template of the same is given below in Figure 1.

Figure 1 **Industry classification based on export performance and world demand dynamism: Template for graphical analysis**



In Figures 2 - 6, we analyse the main industries in five different Asian economies, using the template described in Figure 1. Different positions on the vertical axis illustrate the difference in world growth rates of different manufacturing industries, whereas different positions on the horizontal axis show whether countries' shares in dynamic or static industries increased or decreased. In addition to charts, we provide a table (Tables 6 – 10) corresponding to each chart in which we categorize manufacturing industries into champions, champions in adversity, declining and underachievers.

Figure 2 Thailand



In Thailand, we can classify industries in the following way:

Table 4 Industry classification of Thailand

Champion	Champion in Adversity	Declining	Underachievers
Food and beverages	Wood products	Tobacco	
Coke and refined petroleum	Paper	Textiles	
Chemicals	Printing and publishing	Wearing apparel	
Rubber and plastics	Office, accounting and computing machinery	Leather products	
Basic metals	Radio, television and communication equipment	Non-metallic minerals	
Fabricated metals	Motor vehicles, trailers and semi-trailers		
Machinery and equipment	Other transport equipment		
Electrical machinery	Furniture, n.e.c.		
Precision instruments			

In Indonesia, we can classify industries in the following way:

Figure 3 Indonesia

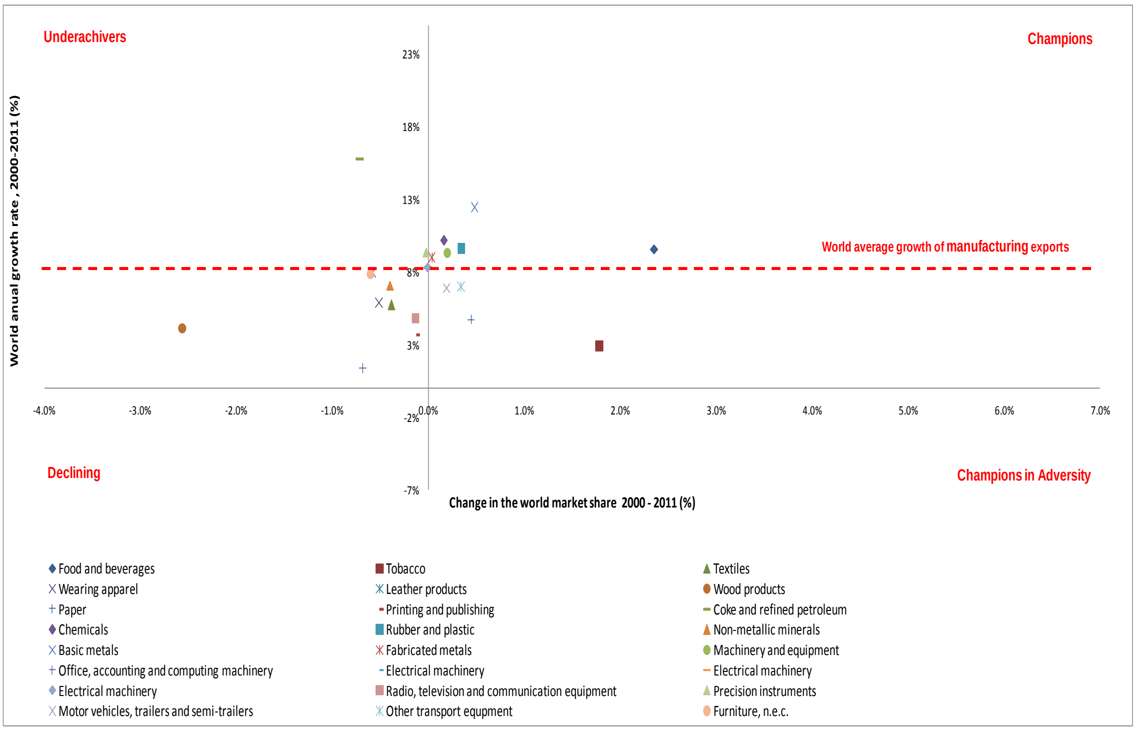
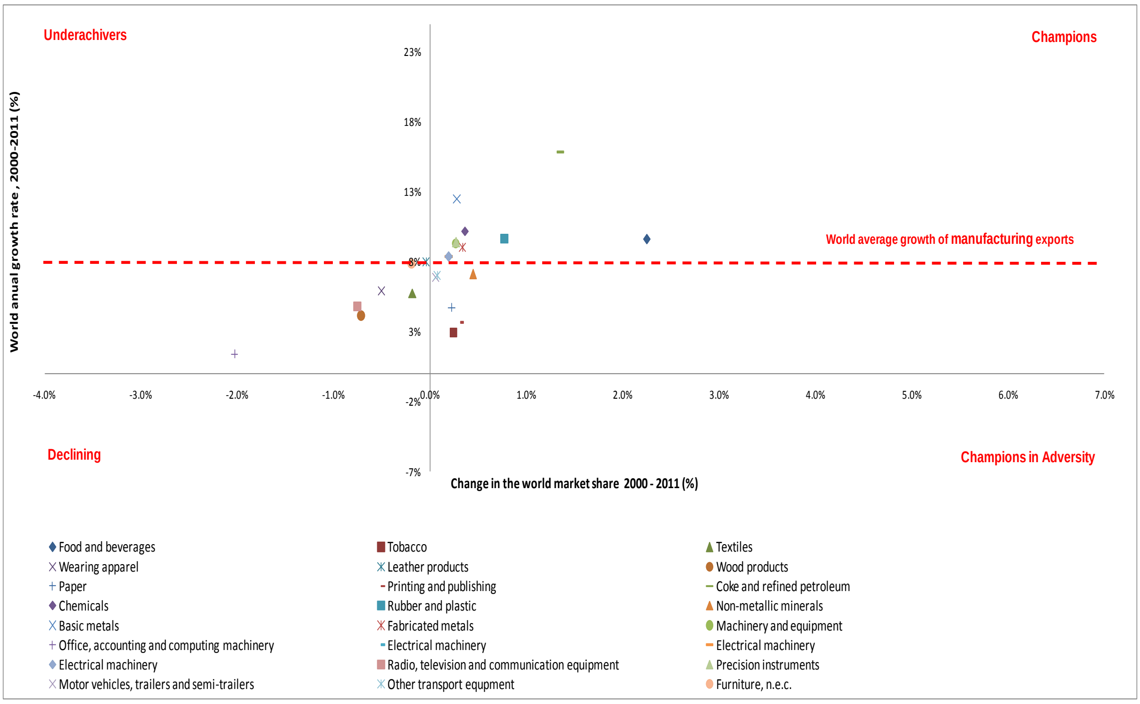


Table 5 Industry classification of Indonesia

Champion	Champion in Adversity	Declining	Underachievers
Food and beverages	Tobacco	Textiles	Coke and refined petroleum
Chemicals	Paper	Wearing apparel	Electrical machinery
Rubber and plastics	Motor vehicles, trailers and semi-trailers	Leather products	Precision instruments
Basic metals	Other transport equipment	Wood products	
Fabricated metals		Printing and publishing	
Machinery and equipment		Non-metallic minerals	
		Office, accounting and computing machinery	
		Radio, television and communication equipment	
		Furniture, n.e.c.	

Figure 4 Malaysia

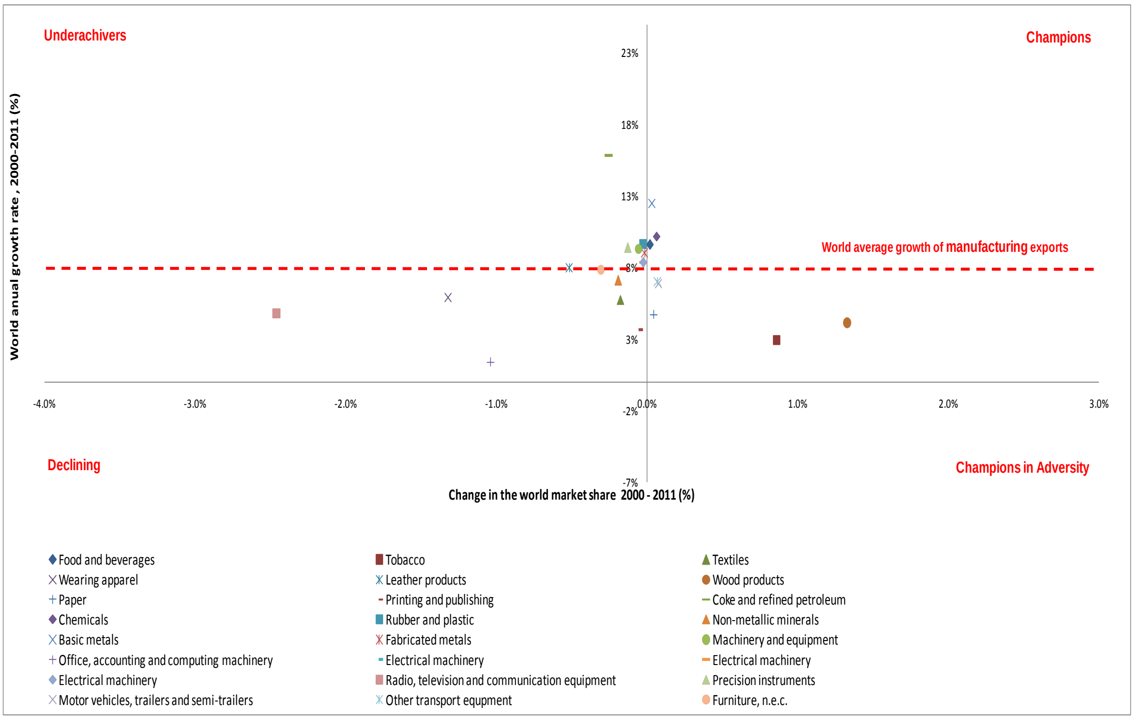


In Malaysia, we can classify industries in the following way:

Table 6 Industry classification of Malaysia

Champion	Champion in Adversity	Declining	Underachievers
Food and beverages	Tobacco	Textiles	
Coke and refined petroleum	Paper	Wearing apparel	
Chemicals	Printing and publishing	Leather products	
Rubber and plastics	Non-metallic minerals	Wood products	
Basic metals	Motor vehicles, trailers and semi-trailers	Office, accounting and computing machinery	
Fabricated metals	Other transport equipment	Radio, television and communication equipment	
Machinery and equipment		Furniture, n.e.c.	
Electrical machinery			
Precision instruments			

Figure 5 The Philippines

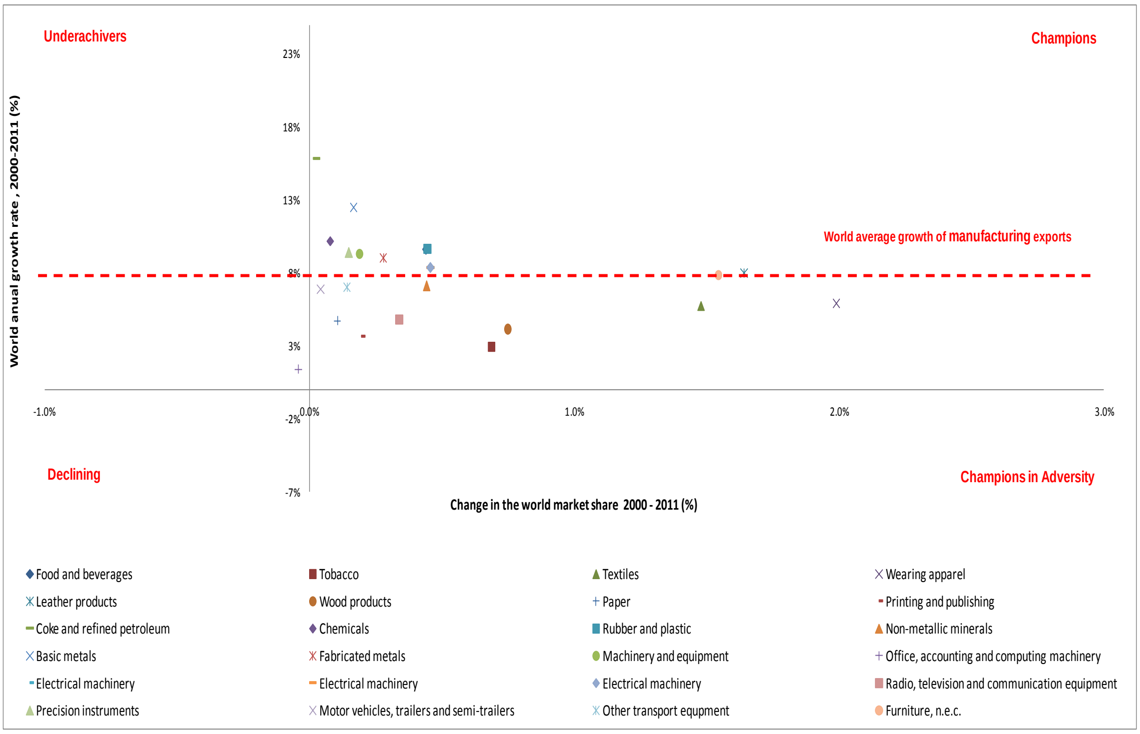


In the Philippines, we can classify industries in the following way:

Table 7 Industry classification of the Philippines

Champion	Champion in Adversity	Declining	Underachievers
Food and beverages	Tobacco	Textiles	Coke and refined petroleum
Chemicals	Wood products	Wearing apparel	Rubber and plastics
Basic metals	Paper	Leather products	Fabricated metals
	Motor vehicles, trailers and semi-trailers	Printing and publishing	Machinery and equipment
	Other transport equipment	Non-metallic minerals	Electrical machinery
		Office, accounting and computing machinery	Precision instruments
		Radio, television and communication equipment	
		Furniture, n.e.c.	

Figure 6 Viet Nam



In Viet Nam, we can classify industries in the following way:

Table 8 Industry classification of Viet Nam

Champion	Champion in Adversity	Declining	Underachievers
Food and beverages	Tobacco	Office, accounting and computing machinery	
Coke and refined petroleum	Textiles		
Chemicals	Wearing apparel		
Rubber and plastics	Leather products		
Basic metals	Wood products		
Fabricated metals	Paper		
Machinery and equipment	Printing and publishing		
Electrical machinery	Non-metallic minerals		
Precision instruments	Radio, television and communication equipment		
	Motor vehicles, trailers and semi-trailers		
	Other transport equipment		
	Furniture, n.e.c.		

It should be noted that this analysis is not conclusive as it focuses merely on one dimension of export performance. To fully assess industries' competitiveness, we would need to conduct an in-depth analysis of the impact on domestic demand and the extent and complexity of industries' capabilities. Despite the limitations, the above analysis provides key insights into industries' performance which reflect the country's ability to compete internationally.

2.3.2 Analysis of domestic demand

In the previous section, we identified the industries that are growing fastest in terms of international demand and showed how countries were able to change their shares in global industry. In this section, we apply a similar analysis, but at the domestic level.

Here we are interested in determining the extent to which local demand for the domestically manufactured products of the given industry is met. For this purpose, we utilize input-output tables, where demand is calculated as the sum of intermediate and final demand. Unfortunately, no input-output table was available for Viet Nam. Due to the reliance of this analysis on input-output tables, our analysis covers a period of 10 years, from 1990 to 2000 (Table 9).

Table 9 Analysis of domestic demand

	Indonesia		**Thailand**		**Malaysia**		**Philippines**	
	1990	2000	1990	2000	1990	2000	1990	2000
Food, beverages and tobacco	20272307	35461547	12030832	17937153	8241611	10369293	15006280	21538191
Textiles, leather, and related products	4839094	6830900	11424975	13381231	1441779	2125290	2048341	1000186
Timber and wooden products	2053818	2418973	2510876	1353797	1336720	1315252	882132	792653
Pulp, paper and printing	2158039	3831847	1444249	3190597	1206170	2289465	852086	702668
Chemical products	3746544	6245090	2207372	7457575	1323808	2512081	2201965	2155984
Petroleum and petro products	5203241	4608005	3294789	9468871	1584265	6018621	2649185	4328475
Rubber products	1249919	1142623	1394073	1587099	2872557	433593	462460	316079
Non-metallic mineral products	1288538	2110361	3683224	3040794	825074	2215456	901533	1030880
Metal products	3797178	4953324	3165494	3580371	1738268	5981726	1607541	1630060
Machinery	3924351	4027312	4460615	5763394	1842666	5428301	779780	1347118
Transport equipment	5857591	12110734	8629566	9593354	1388152	5187866	559932	658025
Manufacturing	55383069	87457132	57297384	83398063	24454536	46724504	28666200	36212504

We then proceed to calculate the annual growth rate of domestic demand using the compound annual growth rate formula.

$$CAGR_i(y_2 - y_1) = \left(\frac{dd_i(y_2)}{dd_i(y_1)}\right)^{\frac{1}{y_2 - y_1}} - 1$$

Where $dd_i(y_k)$, is the demand in industry *i* in year y_k

We determine whether domestic demand for products of a particular industry was higher than for the manufacturing average. Those industries that are growing faster in terms of domestic demand than average manufacturing domestic demand are considered as having 'dynamic' demand, and those industries that grow slower than the average are considered as having 'static' demand.

Table 10 Domestic demand for products from different industries

	Indonesia		**Thailand**		**Malaysia**		**Philippines**	
Food, beverages and tobacco	5.75%	Dynamic	4.07%	Dynamic	2.32%	Static	3.68%	Dynamic
Textiles, leather and related products	3.51%	Static	1.59%	Static	3.96%	Static	-6.92%	Static
Timber and wooden products	1.65%	Static	-5.99%	Static	-0.16%	Static	-1.06%	Static
Pulp, paper and printing	5.91%	Dynamic	8.25%	Dynamic	6.62%	Static	-1.91%	Static
Chemical products	5.24%	Dynamic	12.95%	Dynamic	6.62%	Static	-0.21%	Static
Petroleum and petro products	-1.21%	Static	11.13%	Dynamic	14.28%	Dynamic	5.03%	Dynamic
Rubber products	-0.89%	Static	1.31%	Static	-17.23%	Static	-3.73%	Static
Non-metallic mineral products	5.06%	Dynamic	-1.90%	Static	10.38%	Dynamic	1.35%	Static
Metal products	2.69%	Static	1.24%	Static	13.15%	Dynamic	0.14%	Static
Machinery	0.26%	Static	2.60%	Static	11.41%	Dynamic	5.62%	Dynamic
Transport equipment	7.53%	Dynamic	1.06%	Static	14.09%	Dynamic	1.63%	Static
Other manufacturing products	14.11%	Dynamic	8.73%	Dynamic	15.86%	Dynamic	-0.04%	Static
Manufacturing	4.67%		3.83%		6.69%		2.36%	

We now need to determine whether local industry responded to the domestic demand dynamics by increasing local production. The extent of expansion of domestic industry is captured by comparing the industry's value addition to the total industrial value addition. The share of the country's industries' value added (VA) in its total manufacturing value added (MVA) is calculated for the period 2000 to 2011 to measure the impact of that particular industry according to the following formula:

$$VASHARE_{c,i}(y_t) = \frac{va_{c,i}(y_t)}{MVA_{w,i}(y_t)}$$

For this we use INDSTAT value added data. The share of VA in manufacturing VA of a given industry gives us the competitive position of that industry relative to others. Gains in market share reflect improved domestic competitiveness, while losses signal a deterioration of the industry's competitive position. The change in share between two different years is calculated as:

$$\Delta VASHARE_i = VASHARE_{c,i}(y_2) - VASHARE_{c,i}(y_1)$$

Similar to export analysis, we can combine the information of the above two tables into a graph. On the Y-axis, we show the changes in domestic demand for products from industries from 2000 to 2011, and the X-axis illustrates changes in value added for the specific industry in the country's total manufacturing value added (MVA). The dotted line represents the average domestic growth of total manufacturing demand during the same time period. Industries that register domestic demand growth over the manufacturing average (i.e. above the dotted line) while at the same time recording a positive change in the ratio of industry value added to total manufacturing value added, will be considered a 'Local Champion'.

In the graphs below, we carry out an analysis of local demand and production of nine major manufacturing industries in Indonesia, Thailand, Malaysia and the Philippines. We identify 'local champions' in each county. For instance, chemical products, pulp, paper and printing, transport equipment and non-metallic mineral products emerged as 'local champions' in Indonesia, while Thailand has two local champions - pulp, paper and printing and chemical products. The machinery industry emerges as the only 'local champion' in Malaysia and the Philippines. Basically, these are industries that witnessed considerable domestic demand growth over 1990-2000 and the local manufacturing sector responded to this rise in demand by increasing production. The fact that local producers were able to respond to the growth in domestic demand effectively implies that these are industries in which the country has local production capabilities and resources in terms of production inputs and skilled work force.

Table 11 Changes in domestic demand for products

ISIC Category	Indonesia	Thailand	Malaysia	Philippines
Food and beverages	-3.63%	-4.50%	-4.08%	-9.73%
Tobacco	-5.84%	-1.53%	-1.09%	-1.18%
Textiles	0.52%	-17.79%	-0.96%	-2.16%
Wearing apparel	1.60%	0.54%	-1.47%	-1.68%
Wood products	-4.45%	0.50%	-2.59%	-1.22%
Paper	0.29%	1.93%	0.29%	-0.01%
Printing and publishing	1.67%	1.06%	-0.95%	0.13%
Coke and refined petroleum	0.15%	3.45%	6.38%	3.52%
Chemicals	1.58%	4.57%	-2.87%	-1.88%
Rubber and plastics	-0.75%	1.18%	-1.64%	-0.37%
Non-metallic minerals	0.36%	-4.13%	-1.34%	0.15%
Basic metals	-5.29%	0.72%	-1.08%	-0.28%
Fabricated metals	0.25%	2.00%	-0.28%	-0.13%
Machinery and equipment	-0.24%	2.35%	4.88%	4.22%
Electrical machinery and apparatus	7.47%	5.54%	7.34%	8.70%
Precision instruments	0.44%	0.54%	0.13%	1.83%
Motor vehicles	5.05%	3.97%	-1.55%	0.71%
Furniture, n.e.c.	0.82%	-0.42%	0.87%	-0.64%

Figure 7 Local demand and production analysis: Indonesia

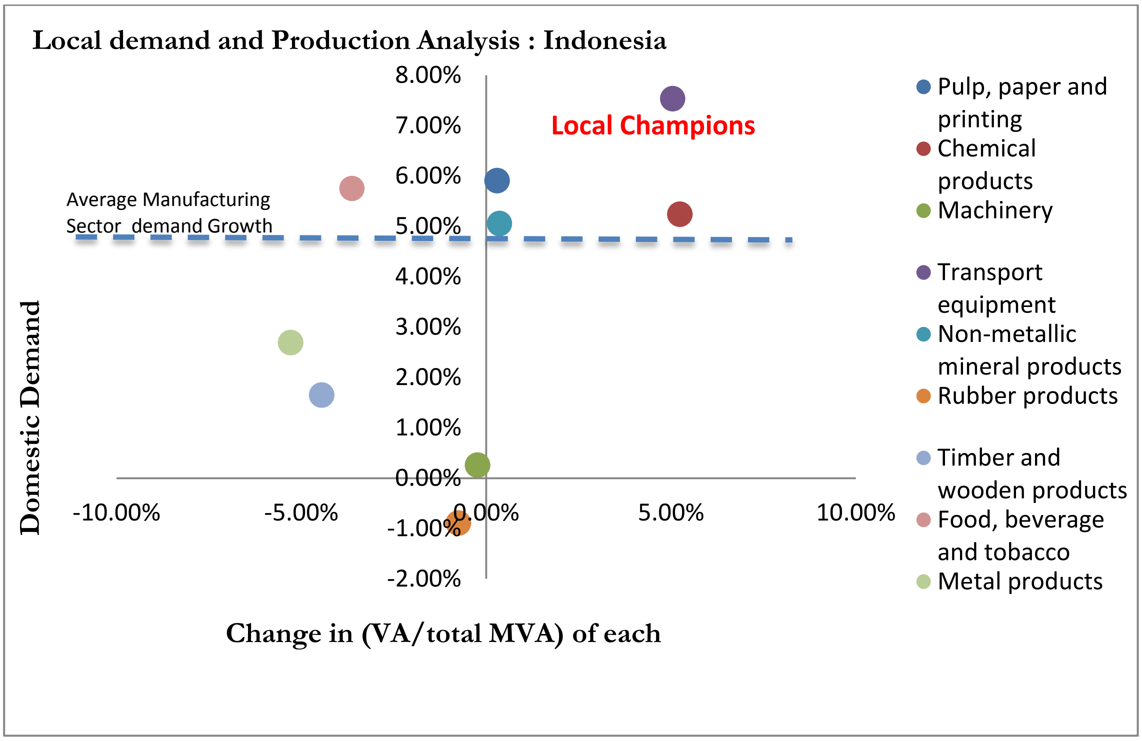


Figure 8 Local demand and production analysis: Thailand

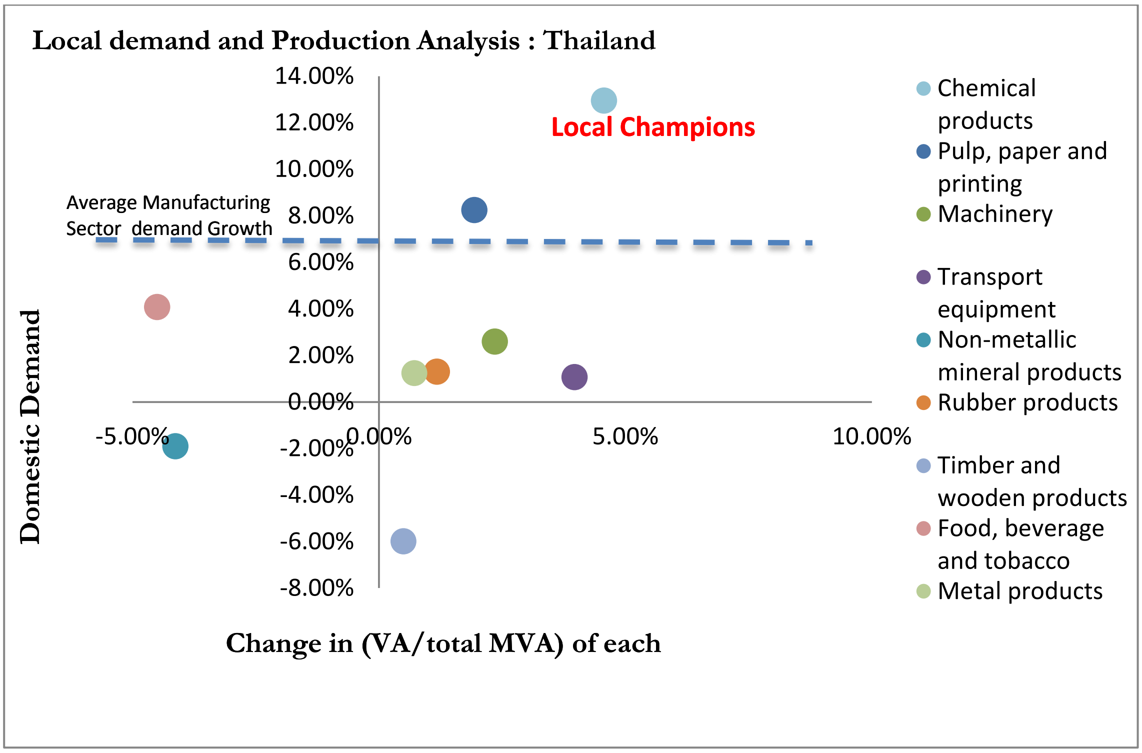


Figure 9 Local demand and production analysis: Malaysia

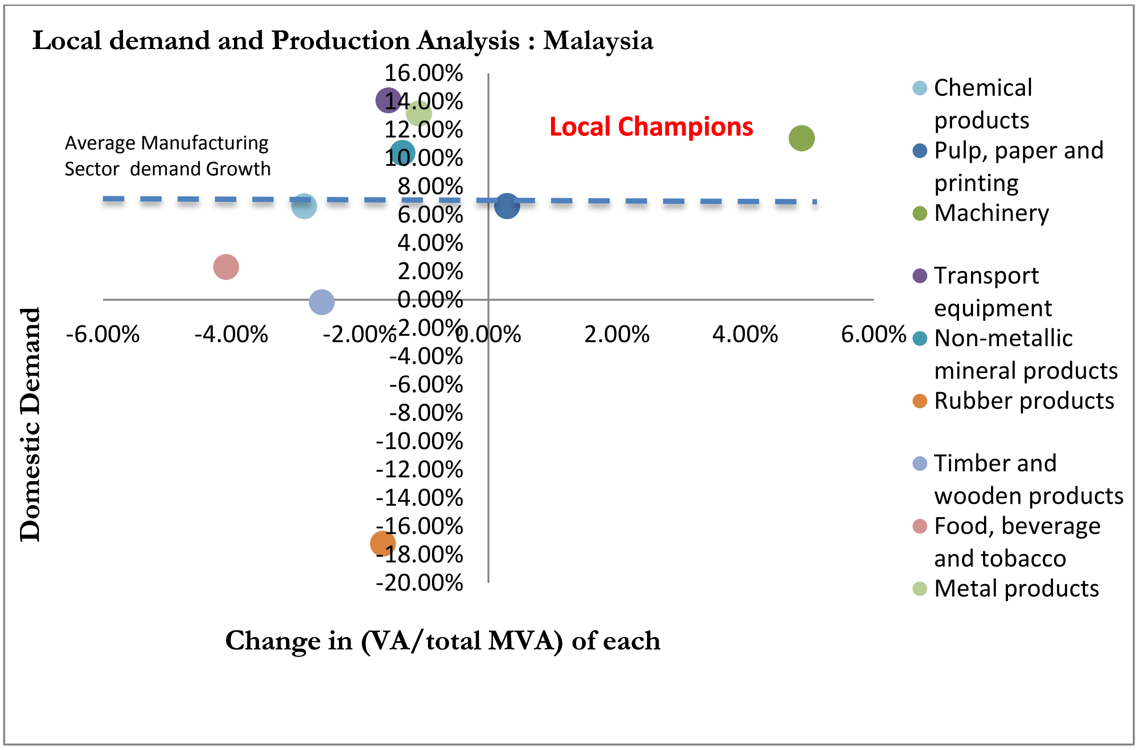
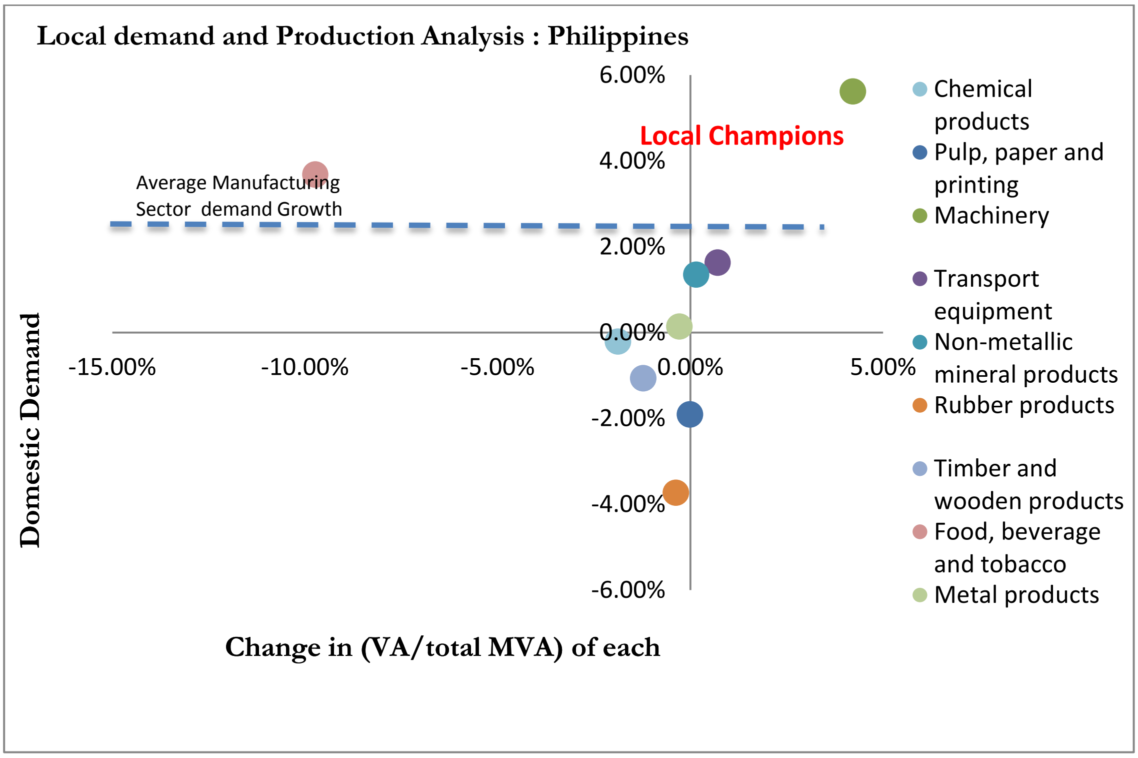


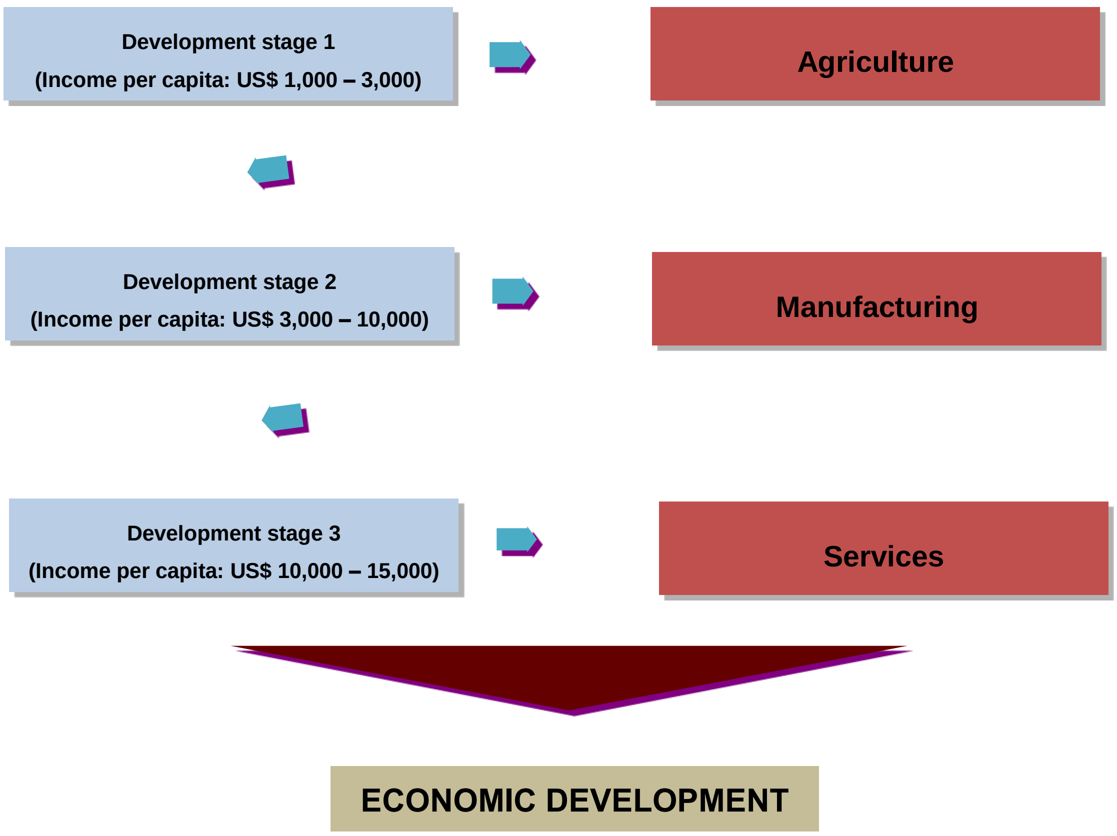
Figure 10 Local demand and production analysis: The Philippines



2.3.3 Analysis of structural change

It is important to compare the evolution and performance of different manufacturing sectors with that of other countries that are in similar stages of economic development or with countries that experienced successful transformation through manufacturing growth and can therefore be considered role models. The structural change analysis described in this section is in essence a comparative analysis. It builds on a comparative advantage argument in the assumption that income level is associated with a country's endowment structures, which entails differences among countries in terms of supply of labour and capital as well as the necessary capabilities. These in turn determine what countries are able to produce and are related to structural change. This means that countries can accumulate capital if they are able to perform well in sectors aligned to their endowment structures and that subsequently their income per capita grows. The implication is that a country's endowment structures also change as it accumulates capital and educates its labour force to acquire higher skills. As a country's endowments change, it can move to more technologically sophisticated industries with higher capital intensity.

Figure 11 The structural change process



(GDP ranges are subject to change – this is just for illustrative purposes).

The chart above shows that in development stage 1 (which roughly corresponds to a GDP per capita range of between US$ 1,000 and US$ 3,000), countries have endowments in terms of labour and capital which are more aligned towards agriculture. As countries' agricultural sector grows, they are able to move to the next development stage. The assumption is that countries will start investing into hard and soft infrastructure during the period of agricultural growth, which changes the country's endowment structure and aligns it towards manufacturing and later towards services.

We apply this logic to the manufacturing sector and exemplify how manufacturing industries move from pre-takeoff, to growth and decline at different income levels. It is assumed that industries with higher growth rates are more labour intensive at lower income levels and that they start declining as income grows, while more capital-intensive industries can sustain high growth rates over a longer income range.

We identify industries that correspond to the selected ASEAN economies' given income level and analyse their deviation from the benchmark pattern in industries determined above.

The structural change assessment methodology is based on the following steps:

1. Step: Identification of relevant country groups with similar exogenous characteristics based on size, resource endowment and other relevant factors. Statistical testing indicates that three major groups share similar patterns of structural change:

   - Large countries: More than 12.5 million inhabitants
   - Medium countries: More than 3 million and less than 12.5 million inhabitants
   - Small countries: 3 million and less inhabitants

All countries selected for this research fall into the 'large countries' category.

2. Step: Estimation of value added shares and growth patterns of manufacturing industries at different income levels (development stage) for the identified country groups using the following model:

$$\ln X_{ct}^{i} = \alpha_1 + \alpha_2 * \ln RGDP_{ct} + \alpha_3 * \ln RGDP_{ct}^{2} + \alpha_4 * \ln RGDP_{ct}^{3} + \alpha_c + e_{ct}^{\ i}$$

   - Where *X* stands for dependent variable: value added share in MVA and value added per capita.

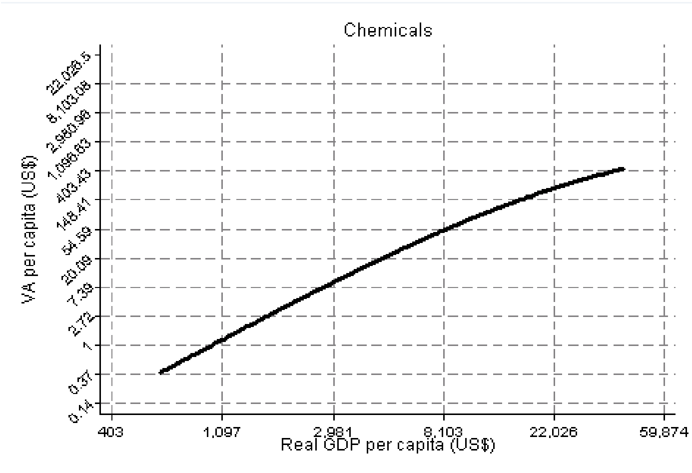
- It is assumed that industries undergo three stages of development— pre-takeoff, growth and decline—following the pattern of a cubic function. Therefore, we employ the cubic functional form using the independent variable real GDP per capita (PPP adjusted): *RGPD.*

- α represents any unobserved effects due to country-specific conditions.

- Both dependent and explanatory variables are expressed in logarithmic terms to measure the elasticity of each variable.

The resulting pattern for the chemicals industry is presented in Figure 12.

Figure 12 **Growth pattern of chemicals industry**



3. Step: Classify industries into early, middle and late industries. The 18 manufacturing industries studied in this report are categorized into early, middle and late industries depending on whether an industry reaches its highest share in total manufacturing value added before a GDP per capita of US$ 5,000, of between US$ 5,000 and US$ 20,000 or of over US$ 20,000, respectively.

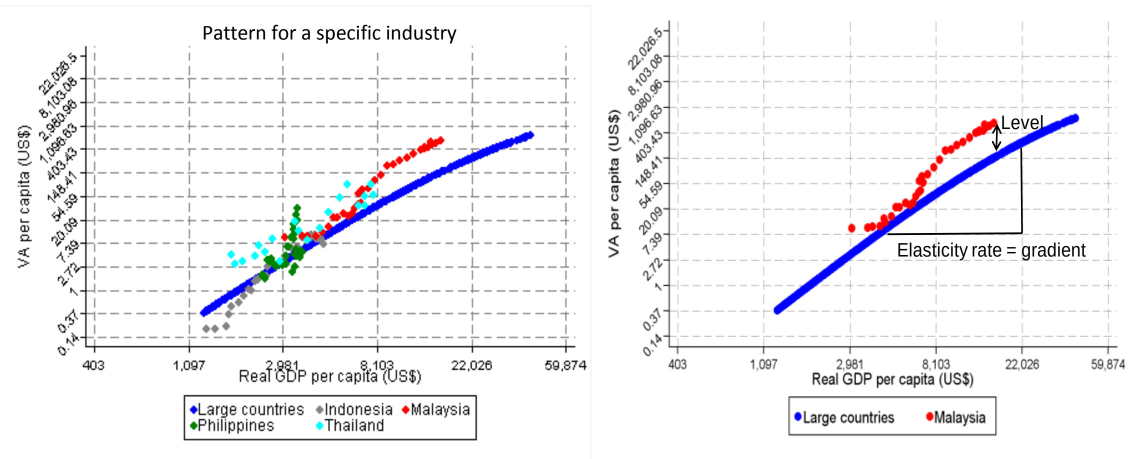
In accordance with the income level of five ASEAN economies, we determine that the Philippines with a real GDP per capita of US$ 4,790.58 and Viet Nam with a real GDP per capita of US$ 3,742.71 have endowment structures which are more conducive for the development of early industries. The endowment structures of Indonesia (real GDP per capita of US$ 5,185.75) and Thailand (real GDP per capita of US$ 5,185.75), are more conducive for the development of middle industries, while Malaysia, with a real GDP per capita of US$ 17,892.7, should focus on late industries.

Table 12 Industry classification

Real GDP per capita (PPP adjusted) range in US$	Industry
Early industries - real GDP per capita (PPP adjusted): US$ 0 - 5,000	Food and beverages Tobacco Textiles Wearing apparel Wood products Printing and publishing Coke and refined petroleum Non-metallic minerals Furniture, n.e.c.
Middle industries - real GDP per capita (PPP adjusted): US$ 5,000 - 20,000	Paper Basic metals Fabricated metals Precision instruments
Late industries - real GDP per capita (PPP adjusted): US$ 20,000 and higher	Chemicals Rubber and plastics Machinery and equipment Electrical machinery and apparatus Motor vehicles

By plotting the time series data of individual countries for GDP and value added per capita on the same graph as that of their country group, the individual country's performance relative to the average benchmark of its country group can be compared in terms of level and elasticity rates.

Figure 13 Country performance and elasticity rate



Difference in level is calculated by

$$D = VApc_{country,latest} - VApc_{benchmark,latest}$$

The rate of elasticity is calculated by

$$E_i = \frac{\dfrac{VApc_{latest} - VApc_{initia}}{VApc_{initia}}}{\dfrac{GDPpc_{latest} - GDPpc_{initia}}{GDPpc_{initia}}}$$

Interpretation:

- If **E>1,** the industry is growing faster than the economy
- If **1> E>0**, the industry is growing, but slower than the economy
- If **E<0**, the industry is declining.

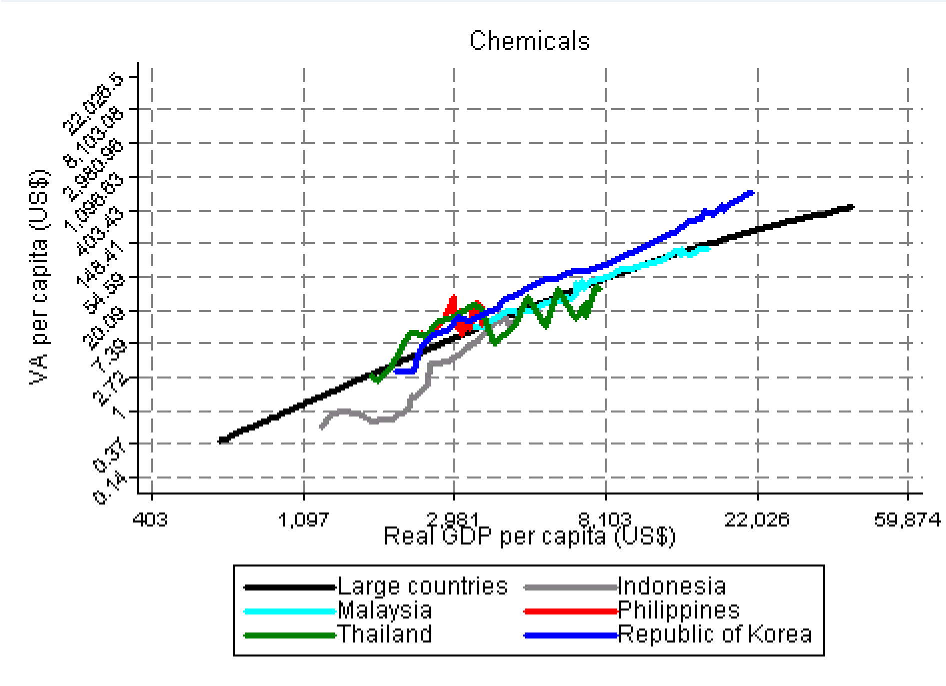
To demonstrate this, we carry out an analysis of the chemicals industry. We were only able to apply this methodology to the chemicals industry in four of the five countries studied here. Long time series data were not available for Viet Nam. The Republic of Korea was included in the analysis as a "role model" country in the region against which to benchmark performance other than the average of all "large countries". The analysis was also limited to the time period for which data was available for the different countries.

Table 13 Value addition per capita

Country	Last year of available data	For last year of available data (measurement point of level)			Level of difference (VApc in US$)
		GDP per capita (PPP adjusted) in US$	Country's VApc in US$	Country Group's VApc in US$	
Indonesia	2003	4607	17	21	-3
Malaysia	2004	15875	128	155	-27
Philippines	1996	3481	25	12	13
Thailand	2002	7528	41	49	-8
Republic of Korea	2004	21332	677	210	467

In terms of level, we find that none of the countries deviated much from the large countries' benchmark average for the last year of analysis. By contrast, value addition per capita in the "role model" country (Republic of Korea) was found to be much higher than the benchmark average at US$ 467 per capita.

Figure 14 **Average growth rates of the chemicals industry**



In the time series analysis shown in Figure 14, the average growth rates of the chemicals industry in Indonesia and the Republic of Korea were found to be significantly higher than that of the large countries' benchmark average. During this period, the Republic of Korea maintained a constant growth rate, while Indonesia started at a significantly lower value added per capita level, but its industry's performance levelled out to the large countries' benchmark average for the last year of available data (2003). The chemicals industry of Malaysia, Thailand and the Philippines had an elasticity rate relatively close to large countries' benchmark average. Indonesia and the Republic of Korea registered considerably higher elasticity rates when compared with their country group average.

Table 14 Time period elasticity analysis

	Time period analysed	Time period elasticity rates		
		GDP per capita (PPP adjusted) range in US$	Elasticity rates of industry in Country	Elasticity rates of sector in Country Group
Indonesia	1970 - 2003	1236 - 4607	10	4
Malaysia	1970 - 2004	3041 - 15875	2	4
Philippines	1963 - 1996	2396 - 3481	3	2
Thailand	1968 - 2002	1712 - 7528	4	4
Republic of Korea	1968 - 2004	2599 - 21332	9	4

2.3.4 Analysis of interdependence of manufacturing industries

In addition to the above analysis, we examined the impact a specific industry has on other manufacturing industries in the country. It is crucial to determine these production linkages among manufacturing industries for policy purposes or whether any interdependencies exist at all among the manufacturing industries.

Defining these linkages and their changes over time is only possible with the use of input-output tables which contain a detailed account of the economic structure in terms of demand and supply at the sub-sector level. Flows from one industry to another within the country can be examined as well as inter-industry flows between the country and another one.

Table 15 presents the manufacturing linkages in the case countries. The calculations are based on backward linkages. Backward linkages exist when the growth of an industry leads to the growth of industries that supply it. The figures in Table 15 show the effect a US$ 1 increase in the output of the respective industries would have on the increase in demand for inputs from all other manufacturing industries, including both direct and indirect effects. Direct effects are purchases of resources (inputs) by an industry from all industries to produce one unit of output. Indirect effects are purchases of inputs by an industry that influence the growth of another industry, which in turn influences yet another industry as well. There can be multiple chains of indirect linkages.

We observe that all manufacturing industries are complementary and that no single industry has a negative effect on the manufacturing sector as a result of its own growth. However, some industries have a more significant impact than others on the growth of manufacturing on the whole.

By comparing the individual linkages with the average, we can determine which industries have higher than average linkages among all other manufacturing industries and would therefore generate higher than average spillovers to the rest of the economy. Industries with above average inter-linkages are classified as 'high impact' sectors. In Table 15 we highlight the 'high impact' industries for each country in yellow. The *food, beverages and tobacco* and the *non-metallic mineral products* industries are 'high impact' industries in all four countries. The fact that these four countries are still predominantly agricultural explains the high degree of linkages. The chemicals industry only emerges as a high impact industry in Malaysia, the Philippines and Thailand, whereby a unit increase in the chemicals industry would trigger a 0.15, 0.11 and 0.13 increase, respectively, in the manufacturing sector on the whole.

Table 15 Interdependence analysis

	Indonesia	Malaysia	Philippines	Thailand
Food, beverages and tobacco	1.18	1.19	1.18	1.18
Textile, leather, and the products thereof	1.15	1.12	1.08	1.16
Lumber and wooden products	1.17	1.16	1.13	1.10
Pulp, paper and printing	1.12	1.12	1.09	1.10
Chemical products	1.13	1.15	1.11	1.13
Petroleum and its products	1.10	1.14	1.04	1.03
Rubber products	1.13	1.15	1.06	1.17
Non-metallic mineral products	1.15	1.14	1.16	1.14
Metal products	1.15	1.09	1.11	1.09
Machinery	1.12	1.06	1.04	1.07
Transport equipment	1.14	1.10	1.13	1.11
Other manufacturing products	1.13	1.10	1.06	1.12
Average	**1.14**	**1.13**	**1.10**	**1.12**

All highlighted sectors are 'high impact' sectors.

2.3.5 Macroeconomic linkages

In addition to exports performance, local demand, the contribution to structural change and local inter-linkages of industries, it is important to evaluate the overall contribution of the manufacturing sector to the economy at the macro level.

We propose using three indicators to establish this overall contribution.

1. **The share of sector exports in total manufacturing exports**: Exports are critical for earning the much needed foreign exchange to balance the economy's current account. The contribution of the specific industry towards total manufacturing export earnings

offers a good indication of the industry's significance in terms of total manufacturing exports.

2. **The share of industry value added in total manufacturing value added:** This indicator measures the contribution of a specific industry to the economy's industrialization intensity. Industries with the highest contributions towards value addition will have a significant role to play in the manufacturing sector's development of the country.

3. **The share of industry employment in total manufacturing employment:** Meaningful employment creation is one of the biggest merits of manufacturing-oriented development. Employment creation and associated skill development are crucial in the development of economies and in poverty reduction. Hence, the contribution of each industry towards total manufacturing employment is a crucial indicator that measures the social and development impact of an industrial sub-sector.

Table 16 provides information on all three of the above indicators for the five countries for the major industries. Data on the average industrial contribution for all five countries is also presented and makes a comparative analysis possible.

Table 16 Macroeconomic linkages

	VA SHARE						EMPLOYMENT SHARE						EXPORT SHARE					
	IND	MAL	PHL	VIE	THA	All	IND	MAL	PHL	VIE	THA	All	IND	MAL	PHL	VIE	THA	All
Food and beverages	17.0	8.8	19.1	25.0	14.0	**16.8**	16.7	9.3	15.3	17.3	16.2	**15.0**	23.7	15.0	10.2	16.8	14.4	**16.0**
Tobacco	10.6	0.3	3.3	5.2	1.8	**4.2**	7.5	0.3	0.9	0.8	0.3	**1.9**	0.5	0.2	0.6	0.3	0.0	**0.3**
Textiles	7.1	0.8	1.1	4.6	3.8	**3.5**	12.4	2.0	3.0	8.1	8.2	**6.7**	5.0	0.8	1.1	9.0	2.1	**3.6**
Wearing apparel	3.8	1.0	3.3	8.7	3.5	**4.1**	11.7	4.1	14.2	14.1	9.1	**10.6**	5.3	0.5	3.6	13.6	1.2	**4.8**
Leather products	1.7	0.2	0.5	7.7	1.6	**2.3**	4.7	0.5	1.6	19.1	3.3	**5.8**	3.1	0.1	0.2	10.8	0.9	**3.0**
Wood products	3.2	2.9	0.4	1.3	1.2	**1.8**	6.3	7.1	2.4	3.9	2.8	**4.5**	2.9	2.0	5.2	1.7	1.0	**2.5**
Paper	5.9	1.3	1.3	1.8	2.1	**2.5**	3.0	2.2	2.1	2.3	2.1	**2.3**	4.8	0.5	0.8	0.5	1.4	**1.6**
Printing and publishing	1.4	2.2	1.1	2.2	1.4	**1.7**	1.3	3.5	1.8	1.4	2.1	**2.0**	0.2	0.2	0.1	0.3	1.9	**0.5**
Coke and refined petroleum	0.6	15.6	9.6	0.4	1.9	**5.6**	0.2	0.3	0.1	0.1	0.2	**0.2**	4.4	6.8	2.0	2.3	5.0	**4.1**
Chemicals	7.0	12.2	6.5	6.3	6.3	**7.6**	1.7	3.9	4.1	3.7	4.1	**3.5**	11.5	9.6	5.5	2.8	11.0	**8.1**

Rubber and plastics	6.2	6.3	2.6	3.4	7.0	**5.1**	7.7	11.7	4.3	3.3	8.1	**7.0**	3.4	4.8	1.7	3.4	5.6	**3.8**
Non-metallic minerals	4.3	3.4	3.6	10.6	3.7	**5.1**	4.0	4.2	2.9	8.1	4.7	**4.8**	0.9	1.1	0.5	1.7	1.2	**1.1**
Basic metals	4.5	4.7	5.2	2.2	3.1	**3.9**	1.4	3.1	2.4	1.9	1.9	**2.1**	10.7	4.4	6.2	3.2	4.7	**5.8**
Fabricated metals	2.6	3.4	1.7	2.6	5.4	**3.2**	2.9	5.7	3.4	2.7	6.6	**4.3**	1.4	1.7	1.1	1.7	2.4	**1.7**
Machinery and equipment	1.7	3.1	3.5	1.5	5.5	**3.1**	1.9	3.8	2.8	2.0	4.2	**2.9**	4.1	5.3	1.9	4.7	8.5	**4.9**
Office, accounting and computing machinery	0.1	8.7	7.0	0.9	1.0	**3.5**	0.1	5.9	7.1	0.2	1.2	**2.9**	0.8	8.6	13.1	0.7	7.3	**6.1**
Electrical machinery	2.2	3.3	4.3	3.3	3.1	**3.2**	1.9	3.8	5.9	2.4	3.2	**3.4**	3.7	4.2	9.0	5.6	4.6	**5.4**
Radio, television and communication equipment	3.3	13.7	18.6	2.5	14.7	**10.6**	3.3	14.7	15.0	1.0	7.6	**8.3**	5.4	26.2	25.5	6.4	9.4	**14.6**
Precision instruments	0.2	1.5	1.5	0.5	1.4	**1.0**	0.5	1.9	2.2	0.4	1.0	**1.2**	0.7	3.4	1.8	1.5	2.2	**1.9**
Motor vehicles, trailers and	7.4	2.9	3.0	3.0	12.3	**5.7**	1.8	2.9	2.6	0.8	4.2	**2.5**	2.6	0.7	6.3	0.9	9.0	**3.9**

semi-trailers																		
Other transport equipment	17.0	8.8	19.1	25.0	14.0	**16.8**	16.7	9.3	15.3	17.3	16.2	**15.0**	23.7	15.0	10.2	16.8	14.4	**16.0**
Furniture, n.e.c.	10.6	0.3	3.3	5.2	1.8	**4.2**	7.5	0.3	0.9	0.8	0.3	**1.9**	0.5	0.2	0.6	0.3	0.0	**0.3**

2.3.6 Limitation of methodologies

Analysis of exports

- The methodology is useful to assess industries that are already exporting. It does not take into account potential goods the country could be producing but is not presently exporting. Hence, our analysis is not 'forward looking' in that respect.
- The methodology does not take into account the diversity of the industries. In cases where the products of an industry are very diverse, variations in performance of these products are expected relative to the average world growth of the manufacturing sector.
- We also assume that industries that have remained dynamic over the last ten years will continue to be so in the future. This may not be completely innocuous considering the dynamics and competition that exist in the international manufacturing sector, resulting in a constant emergence of substitutes and new product lines.

Analysis of domestic demand:

- This analysis does not indicate for which products there is growing domestic demand, and we cannot establish whether the country is importing more intermediates or finished goods.
- The analysis also does not divulge the share of manufactured output of a specific industry, which ends up on the domestic market.

Analysis of structural change

- The analysis is based on benchmarking a country's performance to an average of countries with the same endowment structure. This methodology generates two criticisms: firstly, that endowment structures are determined solely based on income per capita, and secondly, that it implicitly sets the bar against which performance is judged based on what average peers have achieved rather than the country which has excelled in that industry. This also raises the question whether it is in fact not recommended for countries to have a lower share of a specific industry and a higher share of another one than their peers' average. Hence, this analysis is only used as a reference tool, not one from which any actions are recommended.

- In addition to factor endowments, there are also historical and socio-political factors which can have an impact on a country's competitiveness and these are not accounted for in the methodology.

Analysis of interdependence of manufacturing industries

In his early paper, Carl F. Christ (1955: p.140) elaborates two major assumptions in input-output analysis. These assumptions are still applicable today.

- Constant returns to scale. This assumption is contested on the grounds that functions are more complex and that production processes cannot be accurately described using simple shares.

No substitution is possible among inputs in the production of any good or service. According to the author, "the second assumption is sufficient to exclude any optimizing from the supply side, because it excludes all choice about the proportions in which inputs are to be combined in the production of a given output. With such production function, all inputs are perfect complements".

3. Environmental and social analysis

3.1 Background of developing a methodology for environmental and social analysis

As indicated in previous sections, a methodology for the analysis of environmental and social factors has been developed for countries in the ASEAN region, but can be extended to any other country.

Environmental analysis is a complex subject, making it difficult to assess the real-life impact of a single factory or a single product without significant efforts (the accepted methodology of Life Cycle Analysis to ISO14040 can require many person-weeks to deliver an assessment impact that will not necessarily be complete) (Guinee, 2002). Analyses at the level of an industry or nation are even more difficult; for example, an accurate analysis implies analysing each product made in each factory requiring efforts in person-weeks, but it would be difficult to collect data on materials and processes used in practice and across other parts of the product life cycle, such as the user, even if such major efforts are applied (Baumann and Tillman, 2004). In addition, there are methodological challenges such as how one accounts for the manufacture of machines used in other factories so that their impacts are not double-counted, and how one accounts for the system that supports the production of a particular product, such as allocating the impact of building the factory itself and sharing this among the many products made there. Of particular current debate are the challenges of analysing industries and nations, given their interdependencies (the chemicals industry, for example, uses photocopiers, etc.). Industrial and national impact assessments are carried out but are often contested, and such analyses are not being successfully conducted in newly industrializing countries, where national statistical mechanisms are still developing (Beamon, 1999). Nevertheless, there is a pressing need from the industrial policymaking process perspective to conduct some type of environmental and social impact analysis for an industry within a nation.

The methodology proposed here uses the following principles to deal with these challenges:

1. Pareto: we curb the requirements of data collection and processing by focusing on key environmental impacts. The use of the six dimensions (see section 3.2.2) of performance for analysing each industry simplifies data collection. The risk of failing to recognize a critical dimension of environmental performance is reduced by collecting global industrial 'hotspots', i.e. by studying key global reports, we identify any issues that may be specific to that industry. This also allows industrial analyses to focus data collection on crucial environmental and social dimensions (for example, the water consumption of the electronics industry is not an issue and thus does not need to be taken into account in an environmental assessment of the industry).

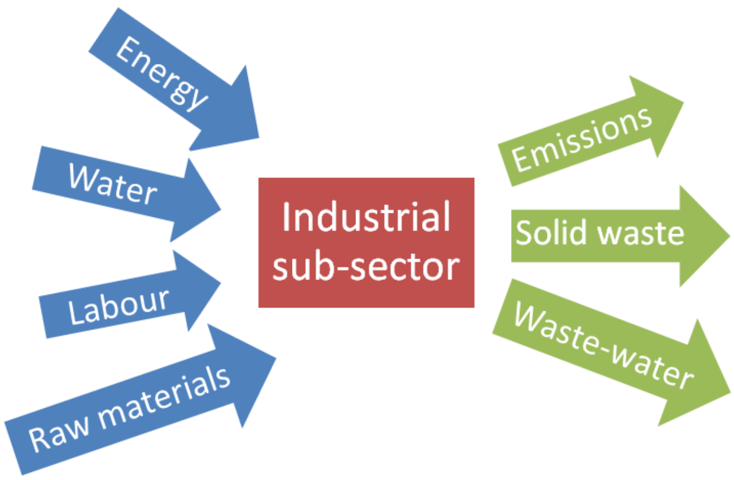
2. Proximity: we further simplify data collection and promote integration with economic analysis by assessing the environmental and social performance of the country with reference to its national capacity. By better understanding national limits for water extraction from rivers and the ground (which enables water c*onsumption* by industry), for example, we can quickly assess whether an industry's growth will create an adverse effect and potentially reduce the scope for industrial growth. Most data on national capacity can be collected from national reports, government departments and statistics offices, and can be used across industries.

3. Potential value: much of the analysis mentioned above focuses on negative constraints. This part of the analysis seeks to determine whether national or industrial strengths exist which have not yet been fully exploited. We refer to these as 'coolspots' and can be found through local searches and by looking at best practices globally, which may or may not be used locally (for example, some industries apply global best practices that re-use waste by-products to enhance total value which, however, cannot be used locally).

4. Practical: the analysis and the ability to use the analysis must be feasible in terms of data collection, time, cost and effort. It is envisaged for government officials (primarily ministries of industry and environment) to use this methodology, which have the necessary network and authority to minimize the time, effort and cost of collecting the required data. It is acknowledged that the early use of the methodology would entail some compromise by reducing its complexity, but through its repeated application, it is envisaged that the policymaking capacity will increase as the filling in of the missing data will be encouraged.

The environmental and social analysis primarily aims to identify physical constraints that can deter or enable an industry's future progress. Different industries hold different capacities for environmental impacts – for example, the primary metals industry uses significant quantities of energy – hence, the analysis seeks to understand both national capacity and industrial demand. Both need to be understood in a nuanced way; national capacity can often change if sufficient plans exist, and industrial demand can change through technological choices, practices and other factors (including differences within industries, as not all parts of an industry generate the same impacts). The methodology therefore focuses on the key environmental and social constraints of energy, material, and water inputs, air, waste and water emissions as well as labour.

Figure 15 Inputs and outputs of industry



The assessment step-by-step

Pre-fieldwork

General preparation

Research industry and country

Choose research country

Preliminary desk research

Research on concept and background of green growth

Review industrial policy of target country

Collect policy documents and share with other researchers and local consultants

Review various industry reports, national competitiveness reports and environmental or social reports for the case countries

Check international databases for data availability

Develop the main concepts and analysis methodology, including detailed interview questions for authorities, industry and NGOs.

Local fieldwork

Define the role of the local consultants

Identify target partners for interviews/forums (from industry, local NGOs and government)

Fix schedules for interviews and forums

Economic analysis

Data collection

Collect data from international productive and trade databases such as UNIDO's Industrial Statistics Database (INDSTAT), the United Nations Commodity Trade Statistics Database (UNCOMTRADE) and the World Bank's World Development Indicators (WDI) as well as country level extended input/output tables:

Economic dimension analysis

Conduct the following economic analyses as described in section 2:

- Competitiveness analysis
- Structural change performance
- Industrial interdependencies

Draft a preliminary report for economic analysis, including implications of the results

Share the outcomes of the economic analysis with other researchers and identify the industrial sub-sectors that offer the highest economic growth potential.

Environment and social dimension analysis (expanded description)

Data collection

Collect as much data as possible for each dimension from online databases and other Internet sources, such as the World Bank Open Data. These databases are studied first for data on the national context, such as total energy availability, and secondly for any insight into specific hotspots (negative impacts) and possible potential value (coolspots) that are known to occur globally for that industry (including searching for local data on actual quantities). Qualitative and descriptive data can usually be found in industry reports and/or international agency analyses for specific industries.

General

Based on the first round of desk analysis, specific data gaps are identified. The future data collection plan for environmental and social analysis is then adjusted to deal with data gaps by focussing efforts on these during local fieldwork. This may also imply partially modifying the national context, industry hotspots and industry coolspots to focus on issues or opportunities identified in the desk research (for example, international reports may demonstrate that certain skills are critical to an industry's good energy performance, and data collection would then be adjusted to seek information on the respective skills capability in the country).

Fieldwork

Local fieldwork

Meet the local consultants to clarify the objectives of the fieldwork

Check any change in interview and forum schedules

Check the arrangements of the forum venues, including payment

Check local transport to the venue where the interviews/forums will take place

The national consultants can, in particular, assist in the process of obtaining interviews with relevant partners and in coordinating the visits.

The majority of interviews should be conducted with relevant authorities, the private sector, industrial associations and NGOs (see Appendix 5 for the list of authorities such as the Ministry for Environment and examples of interview questions).

A small number of forums should be organized to ensure that the opinions of firms across a wide range of firm size are obtained (see Appendix 6).

Economic dimension analysis

General preparation

Arrive in the country with the results of the three economic analyses

Prepare presentation of the three economic analyses (note any data gaps)

Prepare straightforward presentations of the three economic analyses for non-economic experts

Data collection

Obtain new reliable local data for the three economic analyses

Interview

Compare the interview results with those of the economic analyses

Analyse the implications within the context of the economic analyses

Determine the links between the economic analyses and the environmental/social analyses

Forum

Understand the perspective of industry

Synthesis

Integrate the findings of the fieldwork with the results of the analyses

Conclusion

Write the preliminary report.

Environment and social dimension analysis

Data work

Obtain quantitative data

Interviews

Obtain qualitative data from industry, local NGOs and the authorities

Visit the following entities to collect data:

Government

Ministry of Industry, Ministry of Energy, Ministry of Environment, Ministry of Natural Resources, Water Supply Department, Water Treatment Department, Solid Waste Department (or Landfill Department), Department of Labour (Safety), Ministry of Education, National Statistics Office

Industry

Relevant industrial associations, one of the major companies in the industry, a few SMEs of the industry

Local NGOs

Relevant NGOs for environment and labour-related issues

Optionally, meet with local academics and journalists with industry expertise

Forum

To better understand the perspective of industry, meet with a small number of key industrialists and trade association representatives with practical knowledge of the day-to-day challenges. The forum typically focusses on reasons why performance is at the current level, and is hence a search for opportunities where policy can influence performance for the better.

Synthesis

Write up preliminary findings before leaving the country

Identify further points of investigation

Post-fieldwork

Holistic analysis

Secure support for local data collection from the local consultants who will be asked to fill specific data gaps

Develop a map of how to integrate the economic and environmental/social analyses

Conduct holistic analysis and arrive at a conclusion

It may be necessary to modify the research methodology to also include a qualitative analysis of the information collected during the fieldwork after identifying deficiencies in quantitative data.

Report

Write the economic and environmental/ social sections separately

Incorporate the two sections

Write policy recommendations and communicate back to the country.

The integrated analysis will reveal whether an industry can be classified as having medium, high or very high proximity to constraints, indicating that the industry is operating at, near or over the national constraint limits and that there is a current or imminent issue that may cause a growth plan to be delayed or terminated. If an industry is classified as having very low or low proximity to national constraints, it indicates that the dimensions of environmental or social performance, such as water availability, will not materially affect the ability of an industry to grow. The methodology analyses each dimension through the five enabling abilities (constraints, planning, operation, monitoring and education) to better assess the future ability of the nation to support growth in a specific industry. Further explanations are provided below.

3.2 Introduction and conceptual framework

3.2.1 Dimensions for environmental and social analysis

For the analysis of environmental impacts, five dimensions are selected: (1) energy, (2) water supply, (3) air emissions, (4) solid waste and (5) waste water. (6) labour was chosen to analyse the social dimension. These selected dimensions are recommended but not fixed, and can be modified according to the situation of the industry of the research target country.

3.2.2 The original Enabling Abilities Framework for analysing manufacturing processes

The sections that follow provide definitions and examples of the original Enabling Abilities Framework for manufacturing processes' environmental and social dimensions: they explain the 'national context'; 'sector hotspots'; 'velocity of performance'; 'potential for customer value' and 'value missed'. This original design of data collection and analysis is intended to be predominantly quantitative. Though our experience has shown that such a design is not yet practicable, we present it here as it demonstrates the ultimate design objective. The actual process use is described in Section 3.2.3.

Each dimension of performance (energy, water, raw materials, emissions, solid waste, waste water, labour) is analysed by studying the following: national context, hotspots, value missed, customer value and potential, velocity of performance and capacity.

The section on national context examines the country in question and identifies the relevant data regarding constraints (i.e. resources the country lacks or that face significant strain, other disadvantages and what the country does poorly); wealth (what the country does well, resources the country has in abundance or where there is an absence of significant strain), and policies (recent/relevant policy initiatives). These are identified by reviewing historical policy documents, national reports, databases (e.g. data monitor), and they establish the context in which the policy analysis and implementation will take place. A suite of indicators is evaluated at the country level. These are then assigned values which indicate whether they are currently of national concern, and where they will be in a fixed period of time in the future.

Hotspot analysis examines each industry in question, identifying the most prominent negative impacts and selecting the three to six most pressing issues for each environmental and social concern. The data is collected mainly from industry specific reports. The data may also derive from specific national goals, constraints or policies on GHG, energy use, materials use, toxic emissions into the air, water use and/or waste water.

The potential of customer value looks at the industry's products and explores whether the market can exchange an increased value for those performance improvements that could reasonably be introduced. Minimum performance standards usually act as market qualifiers. For example, the prohibition of child labour might be a necessary condition of market acceptance; while some markets might be prepared to pay more when a product uses recycled or renewable materials, which would then become a high 'potential value for customer'. This data is mainly found in global industry reports, OEM reports and meetings with experts; it is measured by the scale of market opportunity, either as a percentage of growth or absolute market scale.

The potential of value missed evaluates each industry individually and examines the opportunities to create value which may not yet have been captured within a particular industry. It assesses the value missed for a given industry in a given country. A typical example is a market for carefully processed by-products, but these rarely materialize because they are uneconomic on their own; by identifying this as a value missed, the industry can consider whether and how to access the value. This data is mainly found in global industry reports, OEM reports and meetings with experts; it is measured by the scale of market opportunity, either as a percentage of growth or of absolute market scale.

The velocity of performance seeks to determine how the industry in the country is performing relative to the rest of the world based on the rate of change of given metrics of performance. For example, the velocity of performance of energy is the ratio between the annual rate of energy efficiency achieved by the industry and the annual improvement in that same industry in the world on the whole.

Finally, the capacity of the industry is calculated based on the proximity to the constraint of that dimension. For each hotspot, current industry performance is extrapolated forward over time based on the rate of recent improvements in industry data and on the comparison with international rates of improvement (velocity). This provides a clear indication of whether or not the industry's growth will become problematic, when it will become problematic, and whether there is room for improvement.

Table 17 Six dimensions of analysis

#	Category	What is to be established?	Environmental indicators	Social indicators	Sources
1	National context	Wealth, constraints, Policies	Resources (water, energy) availability	Employment rate Average wage Wage range Education/skills	Historic policy docs National reports Databases
2	Hotspots	List of 3-6 negative impacts per sector	GHG, SO_2, POPs Heavy metals Toxic leaks, process oils	Reporting frameworks, number of accidents	Industry reports Use norm lists (EWW)
3	Value missed	Gap between price and value	Un-used by-products	Positive externalities (job creation?)	Difficult to find sectoral data
4	Customer Value Add potential	Market opportunity scale	New markets	Employment, Income level	Market research
5	Velocity of performance	Comparative rate of improvement vs row.	Per Hotspot Technical level Management level		Reports indices
6	Capacity	Proximity to system constraints	1,2,5	1,2,5	1,2,5

This section explains the calculations used to support the above analysis (see Table 17).

National context calculates the total available quantity of the resource being analysed, each with its own locally appropriate unit. Energy, for example, will often be stated as a quantity of GWh available per annum. We take both the current figure and any predicted future figures for availability. The current and planned load on the system is also collected to identify 'typical' availability, hence, we have at least two dates with known availability.

$$\frac{(Energy)\ available - (energy)\ used}{(Energy)\ available} \text{ x } 100\% = \text{(energy) available for growth in \%}$$

Hotspots are taken from global lists. Energy, for example, has one major hotspot in CO_2 emissions (in some countries with poor combustion of, say, coal, other hotspots may occur). The hotspots are used to determine which units to use in the above calculation, but do not alter the equation itself.

Value missed and customer value added potential both offer qualitative data that identifies specific areas of opportunity for the industry in the country. For example, the chemicals industry may not record a high value for its by-products when compared with international norms. Wherever possible, these will be analysed to determine the scale of achievable benefit (in US$) if the chemicals sector in the given country was able to apply international norms. Not all of these so-called hotspots can be valorised in a reliable manner (for example, where certain environmental standards form trade barriers and where achieving those standards is viewed as increasing the possible international market share, calculating future market share is not reliable and is therefore not calculated).

Velocity of performance is based on data on the increase of the industry's average efficiency – such data is commonly available for certain industries and environmental dimensions such as automobile manufacturing and energy used in the manufacture of vehicles. The national industry's current rate of improvement is also derived.

$$\frac{\sum annual\ rates\ of\ improvement\ globally\ (energy)}{\sum annual\ rates\ of\ improvement\ nationally\ (energy)} = National\ improvement\ potential$$

Where this number is above 2, there is a clear scope for government/industry joint action to match international norms. Where the specific dimension (say, energy) is severely constrained in that country, the urgency to take action on basic efficiency is highest.

Finally, these calculations are brought together to calculate the industry's capacity to grow.

$$\frac{(energy) used\ by\ this\ industry}{(energy)\ available} x\ 100\% = (energy) demand\ of\ the\ industry\ \%$$

Using the previous calculation $\frac{(Energy)\ available - (energy)\ used}{(Energy)\ available}$ x 100% = (energy) available for growth in %

we can calculate

$$\frac{(energy) demand\ of\ the\ industry}{(energy) available\ for\ growth} = capacity\ of\ the\ industry\ to\ grow$$

The above calculations should use current year data and any future projections available. Where the industry's capacity to grow is above 0.3, the growth of that industry is likely to entail a large share of any future capacity growth and must be considered severely challenging. Where the industry's capacity to grow is below 0.1, the growth of that industry does not impact the ability of other parts of the economy to grow (such as household energy demand), and growth plans can therefore proceed unabated.

We conducted extensive large-scale fieldwork in five countries in the region and found that virtually no physical input or output data is available for many of the dimensions of industrial sustainability performance, with the notable exception of energy data. Accordingly, we had to use the practicality principle to simplify the version of the methodology used, and the revised methodology described in this report is the methodology actually used. The above-described method remains our goal as a rigorous method that can be applied when sufficient data exists.

The aim of developing a methodology for analysing environmental and social issues is to create a new approach for assessing manufacturing in relation to industrial sustainability. It should, however, be noted that the methodology should not be applied when making international comparisons between manufacturing industries in terms of environmental and social analysis.

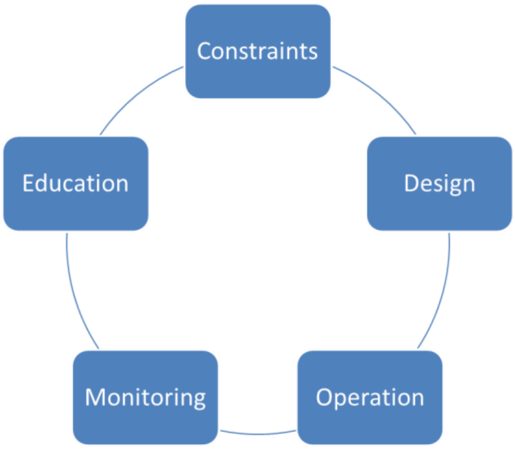
3.2.3 The Five Enabling Abilities Framework used for analysing manufacturing processes

This section describes the revised analysis method we used and its feasibility.

The analysis is structured in a way that goes beyond the typical simple measure of the scale of any environmental or social issue. For each of the six dimensions of environmental and social performance – energy supply, water supply, emissions to air, emissions to water, solid waste and labour – we analyse data across all five enabling abilities (if such data exists). The five enabling abilities are termed constraints, planning, operation, monitoring and education. These provide a framework for identifying parts of the industrial system where the given industry's performance may strongly influence the future ability to continue growing or to provide a healthy environment for citizens (note that raw materials create environmental impacts, but these are not assessed in this methodology for reasons described below).

For example, a nation may currently be operating far below its total capacity to deliver water to industry (though it may have an abundance of water sources, but a poor score in constraint). Planning and education would help identify future water issues that may arise for that industry before it can grow; in this situation, the current constraint score would be very low but with a warning that rapid growth could change the status quo quickly as the infrastructure to support growth is poor. To understand environmental and social dimensions in detail, we must explore the respective abilities individually rather than characterize the entire industry and the dimensions with a single parameter. The definitions of the five manufacturing abilities are provided below:

Figure 16 Five Enabling Abilities Framework



- **Assessment of constraints within the system:** The ability of industry X to understand current and future constraints

  This ability is determined by knowledge. Competent industries will understand how close they are currently operating at the limits of the system they are part of and be able to extend this knowledge into the future and be aware of how close they will be operating to the system's limits, if expansion plans or changes occur. This includes a need to understand the system's limits which are often determined by governments, NGOs or trade bodies. Limits may be national or watershed, of physical or legislative nature or mandated by customers; hence, awareness of limits is complex and a pre-requisite for analysis and planning.

  For example, the ability to model water availability for a catchment area over long periods requires good data as well as an understanding of the ground/river water balance of extraction, weather patterns, etc. Forward planning for industry consumption of water necessitates such forecasting capability.

- **Design of systems:** The ability of industry X to develop a plan for a sustainable future

  This ability is based on the effectiveness of those institutional mechanisms that bring together the many collaborators necessary for effective action (Stead and Stead, 1995). Solutions are developed and implemented by multiple actors – for example, pollution regulations introduced by the government, which are delivered to industry and monitored by NGOs or government bodies and felt by local citizens. Sensible and workable solutions must be designed. This enabling ability is critical for complex interacting systems.

For example, if water is projected to be a constraint in 5 years' time, the ability to bring together large water consumers, water scientists and policymakers to design a solution is a critical capability.

- **Operation of systems**

The ability of industry X to deliver current value within current national limitations.

This enabling ability is linked to the current situation and the industry's performance given the current limitations of the country's industrial system. It focuses on proximity to actual limits. If an industry is currently operating above its limits, then expansion is much more challenging. Equally, demonstrating competence at operating within current limits is a good indicator of the ability to continue to operate within these limits in the future.

For example, given the intermittent nature of water availability, the ability of an industry to arrive at seasonal solutions and continue operating during periods of water shortage is a high capability.

- **Monitoring of systems**

The ability of industry X to assess its own performance.

This enabling ability relates to institutional mechanisms that exist for monitoring, measuring and enforcing performance (Gray and Bebbington, 2001). It entails government competences in the enforcement of current legislation, scientific competence and the capacity for full testing and monitoring, combined with industry competence to monitor at plant level (to avoid failures). The ability to derive such data and use it to guide further action is also considered, as there is little value in accurate reports that go nowhere.

For example, the ability to manage periods of water shortage depends in part on knowing which users consume what quantities and when, as well as government competence at monitoring and hence calculating supply availability. This is an operational capability for day-to-day management.

- **Education for systems**

  The ability of industry X to organize and develop competence/knowledge.

  This enabling ability is concerned with the longer term ability to deliver the four abilities already mentioned. Without competent people, the design, operations, monitoring and understanding of constraints will be severely limited. Therefore, this ability challenges the capability of national institutions to build education programmes and to encourage enrolment. This may be for professional accreditation or at degree level, and may be delivered by academic institutions, trade associations or private companies.

  For example, the education and training of future chemical engineers should enable them to understand water impacts, to measure and monitor water usage and to identify ways to reduce water usage within factories.

This more segmented approach allows us to identify the potential for future problems with any of the seven dimensions considered, as well as the specific abilities that strongly influence the manufacturing sector. It should be noted that these abilities, however, are interdependent.

3.2.4 Additional analysis of each industrial dimension

In addition to the above, we collected the perceptions of authorities, industry and the community on the various constraints.

Authorities, industry and local communities affect firms' behaviour towards the environment (Delmas and Toffel, 2012). Several studies have shown that government regulatory pressures influence firms' adoption of environmental practice (Delmas, 2002; Delmas and Montes-Sancho, 2010; Majumdar and Marcus, 2001; McGee, 1998) and industry pressure affects firms' environmental practices (Arias and Guillen, 1998). Local communities also put pressure on local firms in terms of environmental practices (Florida and Davison, 2001; Darnall et al., 2010; Henriques and Sadorsky, 1996; Raines, 2002; Carmin and Balser, 2002; Dreiling and Wolf, 2001).

A functioning system of checks and balances between industry, governments and citizens is helpful in establishing a robust licence for an industry to operate. Specifically, proper checks and balances should lead to improved environmental and social performance, as well as to improved stewardship of national constraints. By collecting data on how these groups view each other, we can identify potential issues for further analysis (such as learning from NGOs that water emissions might actually be worse than officially published). Currently, this data can only be collected by reading reports distributed by the given representative body and by interviewing them face-to-face. The resulting data can highlight situations that then require further investigation (for example, learning of a lack of monitoring frequency on air emissions is likely to be reported by NGOs and can then guide researchers to seek further data from officials).

Figure 17 A healthy industrial system

Analysis dimensions

To measure an industry's environmental impact, five dimensions are selected: energy used, air emissions, water used, solid waste and waste water. The use of raw materials is not analysed in this report, as these environmental impacts occur in other countries for imported materials or they occur in other sectors such as mining and should not be double-counted, nor do we have data on capacities in other countries. For the social impact analysis, labour conditions for safety, health and training were selected as the only social dimension. This was due to the limited time of the fieldwork and the importance of labour as knowledge spillover. The analysis dimensions allow for varying situations across industries and nations. Scores are given using the five-ranking index shown here (except in cases in which no information is available, which we term blank spots and assign a zero score).

Table 18 **Scoring for each dimension**

Scoring	0	1	2	3	4	5
Meaning	**No data available**	**Not desirable**	**Less desirable**	**Acceptable**	**Very desirable**	**Most desirable**
Constraint	Blank spots	Very close or over constraints	Close to constraints	Neither close nor far from constraints	Far from constraints	Very far from constraints
Design	Blank spots	Not desirable	Less desirable	Acceptable	Very desirable	Most desirable
Operation	Blank spots	Not desirable	Less desirable	Acceptable	Very desirable	Most desirable
Monitoring	Blank spots	Not desirable	Less desirable	Acceptable	Very desirable	Most desirable
Education	Blank spots	Not desirable	Less desirable	Acceptable	Very desirable	Most desirable

3.2.4 Expected analysis

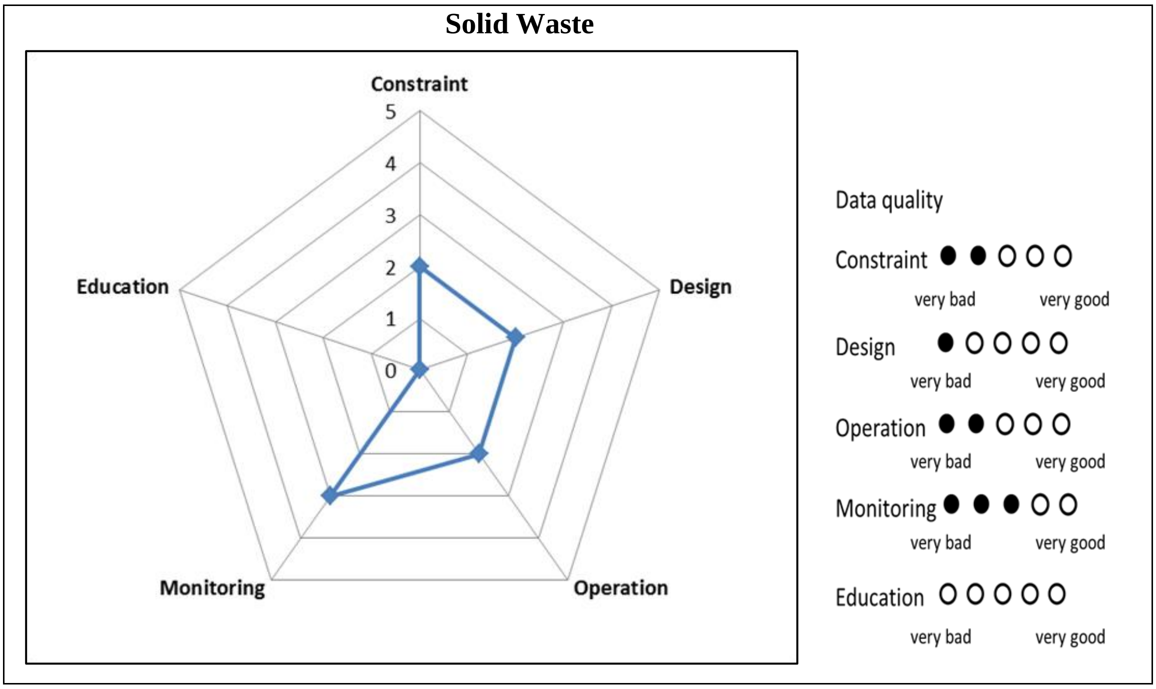
This report analyses six dimensions and five key enabling abilities for a specific manufacturing industry. Our methodology enables us to construct a holistic view of the current and future capability of the industry to support the industry's growth, such as that shown in **Error! Reference source not found.** below. The table provides insights into the environmental and social contexts in which the current manufacturing industry operates. In addition, changes in each dimension and in capability can be easily detected by carrying out an annual table comparison. Once the methods for collecting actual data have been improved, it will be possible to construct a quantitative table similar to Table 19 representing the analysis of actual data.

Table 19 **Example of an environmental and social analysis of a specific industrial sub-sector in a given country**

Qualitative analysis	Constraint	Design	Operation	Monitoring	Education
Energy	Far from constraints (4)	Less desirable (2)	Very desirable (4)	Very desirable (4)	Blank spots (0)
Water supply	Blank spots (0)	Acceptable (3)	Less desirable (2)	Acceptable (3)	Less desirable (4)
Air Emission	Very far from constraints (5)	Acceptable (3)	Very desirable (4)	Acceptable (3)	Acceptable (3)
Solid waste	Less desirable (2)	Less desirable (2)	Less desirable (2)	Acceptable (3)	Blank spots (0)
Wastewater	Very far from constraints (5)	Acceptable (3)	Acceptable (3)	Acceptable (3)	Blank spots (0)
Labour	Blank spots (0)	Less desirable (2)	Acceptable (3)	Blank spots (0)	Blank spots (0)

The data in this table can also be represented in a spiral web diagram as in Figure 18.

Figure 18 Example of solid waste analysis



3.3 Methodological considerations

3.3.1 Lack of data

There is no institutional or international agreement for a list of data on environmental and social impacts at the level of an industry (our analysis). Countries have no obligation to regularly report data to international entities in forms that would facilitate an analysis at industry level; where reporting does exist, it is typically at national level and at too aggregated a level to allow for meaningful analysis at industry level. Voluntary efforts are also extremely limited, making it difficult to create a data set of environmental and social aspects for industry sub-sectoral level analysis from published reports. Of the variables of interest for our study, energy was the only exception, with data at ISIC 2-digit level disaggregation available in the IEA database.

This lack of data affected our ability to conduct a purely quantitative analysis of the environmental and social impacts as originally envisaged (Russo and Amy, 2012). Qualitative research methods were developed where we encountered a lack of data. In the long term, however, it would be desirable for each country to establish an own data collection system and a centralized national environment database to make it possible to carry out environment and social assessments of the country's main industries.

The strength of the methodology to assess industrial sustainability based on physical input and output data is that more precise conclusions can be drawn. However, for this analysis, a rigorous data collection process from which reliable data can be derived is crucial. Rigorous data collection systems for environmental and social aspects at the level of a manufacturing industry and its sub-sectors for each country have not yet been established. There are currently no international bodies that reliably collect data on environmental and social aspects at country level (though many reports are available on these factors, and we drew upon these where they exist). As such, we only had partial information, for example, much of the information that is available sets out the national performance and is not available at industry level (such as total water extracted rather than the water extracted by the chemicals industry specifically). The quality of environmental and social data lags far behind economic data available for the ASEAN region. Therefore, until reliable data is available and a rigorous data collection system is established, the alternative methodology presented below is useful for gaining insights on the environmental and social situation of key manufacturing industries in the countries of the ASEAN region.

3.4 Limitations of the methodology

Like other methodologies, this methodology has several limitations. First, this methodology is based on feedback from interview partners. Accordingly, the result of this methodology may be biased and may include some subjective opinions. Second, this methodology requires considerable fieldwork including interviewing representatives of local government, industry and local communities. For the methodology to be successful, experienced interviewers and local coordinators are needed.

3.5 Suggested improvements for better assessment of environmental and social aspects

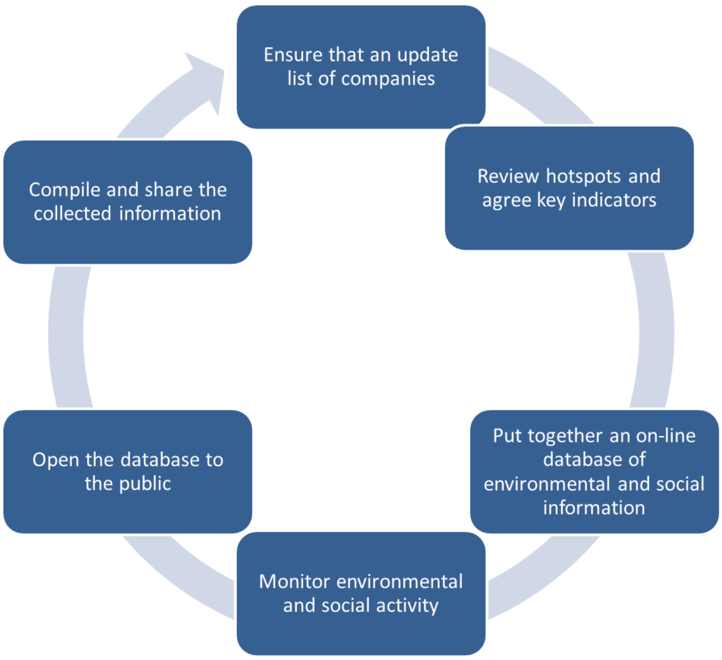
3.5.1 Better measurement design in the future

To improve the design of sustainable industrial strategies for each industry, the physical data collection process needs to be improved. Furthermore, without an appropriate understanding of the current situation of industrial sustainability, most measures relating to environmental and social aspects cannot be properly implemented. To gain a better understanding of industrial sustainability, the qualitative methodology used in this report and its quantitative analysis need to be improved.

The collection of data on environmental and social aspects of the manufacturing industry in the countries of the ASEAN region can and should be improved. Therefore, we suggest the following practical recommendations:

- Ensure that an updated list of companies exists for each manufacturing industry, including SMEs
- Review the hotspots and coolspots with reference to environmental and social aspects (see Appendix 4) and publish these as the key indicators of environmental and social health for the given industry (these will become the standards by which other data is assessed)
- Establish an online database of environmental and social data on official permits for each plant that is opened. For example, firms should submit an operations plan to obtain a permission from local authorities to operate.
- Monitor the specific environmental performance of firms (against permits), including the quantity and quality of regular staff training on environmental and social matters
- Make the database accessible to the public
- For anonymity purposes, compile the data collected at industry sub-sectoral level and share with other countries in the ASEAN region.

Figure 19 Developing a better data management system



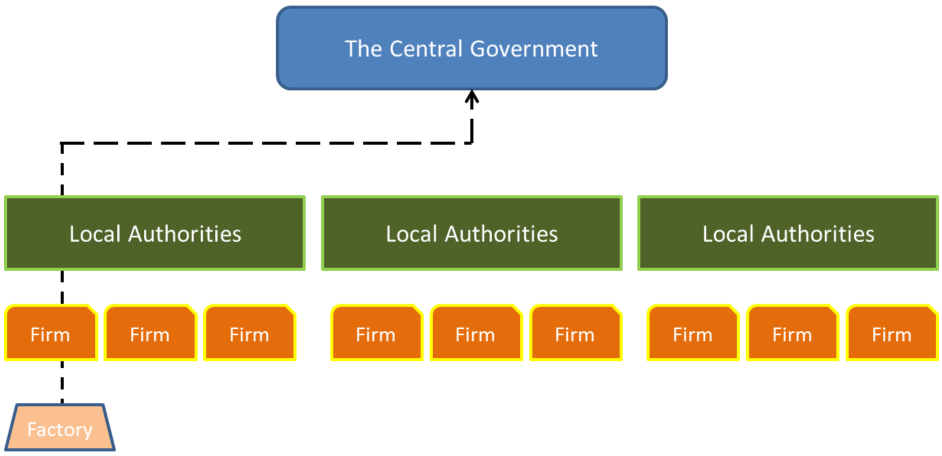
3.5.2 Data collection improvement

To promote better policy design for industry, each country needs to further develop its national data collection and dissemination system for environmental and social data. For example, if authorities want to determine a given industry's water demand, they should be able to construct total water demand from one of two data sources: factories' annual water demand report (to local authorities) or factories' annual water consumption (which can also be collected by local water authorities). Using the industry code for factories, the authorities can then classify the collected information into industry level data. The data collection for all dimensions of environmental and social performance for each industry, such as energy demand, can be improved in the same way.

Not all the data required can, however, be collected in this way. Here we explore an alternative approach to data collection. Measuring the amount of solid waste in a given industry is not a simple task. Local authorities and the central government in many countries collect solid waste data on a regional level. Accordingly, the collection of waste data at the level of industry, e.g. the chemicals industry, is not only difficult, but not necessarily important to local authorities. However, the indirect approach set out below can provide important information on the amount of solid waste and waste water produced at the industry level (see Figure 23).

Typically, in the process of establishing a new factory, the firm is required to report the expected solid waste and waste water production to the local authorities before a license to operate can be issued. Every year, the firm must update these amounts to keep its certification. Data that can support the analysis exists within a given country, but in many cases is neither collected nationally, nor digitized into a searchable format to allow processing at industry sub-sector level. If the government collected the data from waste plans retained by the local authorities, a better picture of regional and industry-based waste production could be painted. The plans' calculations are unlikely to precisely match actual waste production in a region or industry, but can at least contribute to an assessment.

Figure 20 Reporting flows of solid and toxic waste



There are three important implications: first, local authorities should monitor the waste produced by local factories; second, they should monitor the firms' plans for annual waste production; third, firms should have the opportunity to review the amount of their produced waste to compare it with other factories' within the same industry.

This solution works best for data sets that are part of planning approvals or licences to operate. Data on toxic emissions are most likely to be available in comparison to air, water and land (waste). In some industries, energy use is significant and could become part of the licencing regime, but energy data is already well established so such an indirect solution is not necessary. For social performance, labour data may be readily available and this measure may therefore not be necessary.

In most countries, the national agency for safety and health at work monitors and collects information on accidents and deaths in the workplace. If the national agency regularly collects information on workplace-related data, such as accidents and the nature and quality of the working environment, and classifies this data according to industry, it would be helpful to analyse it at industry level. One good example of this practice is the European Agency for Safety as well as the Health Agency, which publish industry reports on different sectors and industries including agriculture, construction, road transport, education and healthcare.

3.5.3 Communication among authorities, industry and local residents

This methodology report finds that there are opportunities to share information that can be used for setting environmental and social targets. We strongly recommend for the three participants (government authorities, industry and local residents) to improve their formal communication across all manufacturing abilities including constraint, design and operation to monitoring and education. All three participants should understand that the five enabling abilities are interlinked and interdependent in terms of delivering environmental and social improvement. In addition, government authorities should recognize that societal awareness of environmental and social factors can help exert a positive influence on the environmental performance of industry in the long term.

Our research shows that there is at least always one firm in many of the countries studied that understands what global best practice means and is implementing a programme to achieve such performance. Such firms are often part of global initiatives, such as the World Business Council for Sustainable Development. Governments would benefit from identifying these firms and encouraging their participation in road-mapping at a national level. Such firms demonstrate which measures are feasible in the country and set a benchmark for other firms in their industry, as well as being capable of planning ahead.

Finally, the development of measurement and monitoring competence is crucial, both within industry and the government, while research and development competence in the emerging area of green technology should also be supported.

3.5.4 Experiences applying the methodology

The methodology was tested in five ASEAN countries with varying experiences. Much of the economic data was available for analysis, though a number of challenges in using the data that is typically available remain.

The environmental and social assessment revealed that a quantified understanding of national capacity was mostly missing from the data sets. National government departments were able to list reports and available data on water issues or waste policies, but these rarely sufficed to conduct a quantitative calculation of capacity. This was not the case for energy availability, where data on the national capacity and even on industry demand was often available.

Therefore, the analysis of how close a particular nation is to its capacity in water consumption, for example, was mostly based on reports with narrower remit or based on expert opinions triangulated against other experts' views. In most cases, data quality was adequate to offer a sensible assessment as to whether the growth of a specific industry was likely to be problematic, and therefore allow an assessment of the industry in one of the five categories.

4. Synthesis of economic, environmental and social analysis

In the previous sections, we developed methodologies to independently conduct an 'analysis of the economic aspects' and 'of the environmental and social aspects' of an industrial sub-sector. In this section, a methodology to combine the earlier analyses is provided to derive appropriate policy recommendations for green growth. Synthesizing these diverse aspects into one framework is challenging and there are multiple ways of how to perform this task. Questions naturally arise regarding which aspects should be given priority and whether these priority standards need to be homogenous across countries.

4.1 Step-by-step description of the synthesis methodology

Hence, in formulating this synthesized methodology, we rely on the principle that any industry with potential in terms of any of the economic dimensions (namely export performance, local demand and domestic multiplier impact) deserves further policy attention. We then screen these industries through an environment and social lens in search of those industries that have the most significant impacts and the least negative environmental and social impacts. It should be noted that we do not recommend closing or withdrawing firms involved in an industry that has an economically or socially positive impact, unless there is the possibility that the industry could have a severely negative environmental impact that cannot be mitigated. In addition, even industries that do not emerge as clear winners in terms of their economic and social dimension are tested to determine whether they have some potential environmental benefits which could distinguish them as a worthy investment. The methodology is designed in such a way that none of the policy recommendations we propose will lead to any significant trade-off in the industry's growth as a whole. Finally, we by no means suggest a 'one-size-fits-all' policy tool; on the contrary, we develop a synthesis framework that incorporates country-specific contexts and local realities. The key advantage of this framework is the fact that we can incorporate the economic, environmental and social dimensions into one framework, a practice which is currently far from representing the norm in the policy arena. Such an integration is indispensable in the quest to realize green growth, and we expect significant further development of this and similar methodologies as we learn more about the practicalities of such integration. The overall structure of our synthesis framework is illustrated in the following flow chart.

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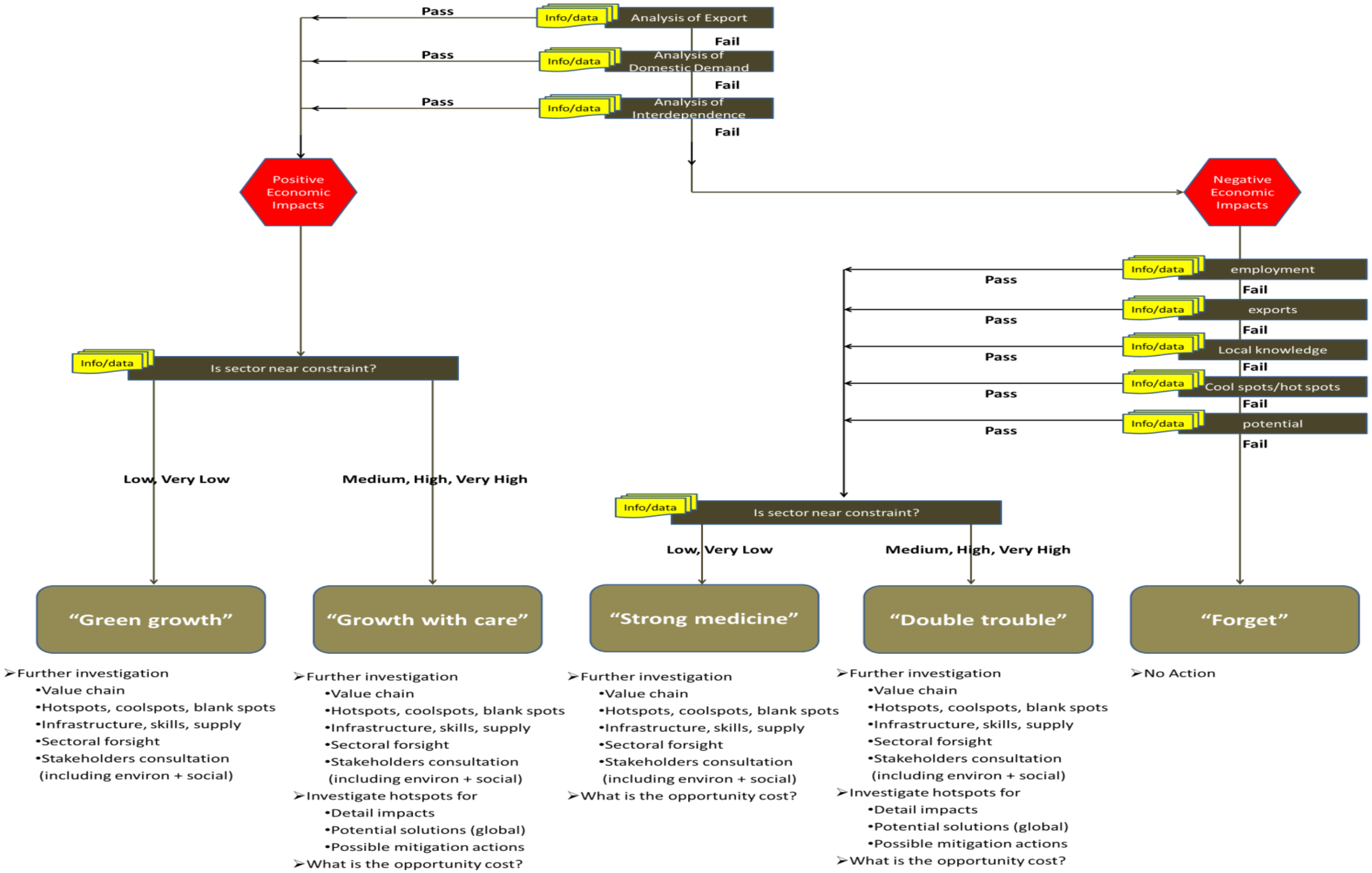
Figure 21 Step-by-step analysis of economic, environment and social aspects



Step 1: The first step in the synthesis exercise is to conduct an economic analysis to test the industry's economic potential. An industry is deemed an 'economic winner' ('Positive Economic Impacts' in the figure) if it meets any of the following criteria:

- The industry is classified a 'champion' or 'under-achiever' in the export analysis carried out in section 2.3.1.
- The industry has been classified as a 'local champion' based on domestic demand and the production analysis conducted in section 2.3.2.
- The industry is classified as a 'high impact' industry based on the domestic interdependence analysis conducted in section 2.3.4.

Step 2: The second step in the synthesis exercise is to conduct the environment and social analysis to test the industry's environmental and social potential. The environment and social analysis is concerned with physical constraints that can hamper or enable an industry's future progress and covers energy, material and water inputs, as well as air, waste and water emissions and labour. Classifying an industry as medium, high or very high indicates that the industry is operating at, near or over the national constraint limits and that there is a current or imminent issue that may cause a growth plan to be delayed or terminated.

If the industry is classified as very low or low in the environment and social analysis, it indicates that the growth of that industry will not be constrained by national capacity.

It should be noted that the analysis does not calculate the industry's future growth targets as the quality of the data in nearly all countries is insufficient. It should also be noted that actual environmental and social impacts occur as part of a larger system where multiple industries influence national capacity.

It does not seem unreasonable to ask whether an industry x can expand by 50 percent over the next 10 years. The quality of the data in nearly all categories is insufficient to answer such a question, but even if it were mathematically possible to extrapolate from current conditions and the data, the answer would fail to take into account other factors such as spillovers (with one industry's growth encouraging other industries to grow, and hence consumption of shared resources such as water would also grow), or the effects of resource productivity (where an industry learns to deliver more value for less original resource) or the effects of increased consumption of resources based on increasing personal wealth and consumption (and hence competition for resources between more affluent citizens and an industry). For these technical reasons, we have chosen not to offer a target or maximum growth figure for any industry.

Step 3: The third step in the synthesis exercise is to establish a recommendation category for the given industry in a given country. This categorization is based on the results of Step 1 and Step 2 and is depicted in Figure 22. Further analysis is recommended to identify the opportunities for improving value creation in the given country and industry, considering economic, environmental and social aspects.

- The policy recommendations are classified into five growth categories: 'Green growth', 'Growth with care', 'Strong medicine', 'Double trouble' and 'Forget.'
- Positive economic impacts lead to one of two categories 'Green growth' or 'Growth with care', depending on the environmental and social impact analysis. Negative economic impacts result in one of three categories 'Strong medicine', 'Double trouble' and 'Forget', depending on the environmental and social impact analysis.

4.2 Policy recommendations for each conclusion

Based on the proposed methodology, the integrated results can be classified into five categories namely 'Green growth', 'Growth with care', 'Strong medicine', 'Double trouble' and Forget. We offer some preliminary guidelines on policy actions required for each of these categories.

4.2.1 'Green growth' industries

These are industries that emerged as 'economic winners' based on our economic analysis; at the same time, they are not near any limitations or negative values set out in our environmental and social analyses.

- Take measures to further improve the competitive positions of these industries by taking strategic policy actions.
- The above policy actions should be additionally assessed by their reduced infrastructure demands and supported accordingly.
- Conduct an 'AEC scenario' analysis of the industry in each country to forecast how the domestic industry will respond to the AEC formation in

2015. Take steps to prepare the industry for possible increased competition.

- If the export analysis reveals that the industry is an 'under-achiever', the country should attempt to improve the industry's export performance through proactive policy interventions to capture the increased world demand in this dynamic industry.

- It is important to study the sustainability of future demand growth for these dynamic industries. If demand growth is found to be short-lived, then the country should not invest too many resources into these industries.

- Skill requirements in these industries need to be studied and the educational institutions in the country must be encouraged to cater to these requirements. This can greatly increase the number of 'green jobs' in the country.

- An industry level value chain analysis needs to be carried out to explore options of producing more value added goods within the industry.

- Given that the industry has no identified environmental or social constraints, the potential for seeking a superior value status for its products in international markets must be assessed. Certification schemes or standards offer one route, seeking out OEMs with strict purchasing standards is another, and finally, own-sector export marketing support (explaining the benefits to buyers) is another.

- The potential for developing new 'green' products that benefit from the lack of local negative impacts should be studied. This offers an accelerated pathway towards higher value adding products.

4.2.2 'Growth with care' industries

These are industries that emerged as economic winners but that are quite near the constraints defined in our environmental and social analyses. Policymakers should consider the following actions:

- Take measures to further improve the competitive positions of these industries by taking strategic policy actions.

- Conduct an ‘AEC scenario’ analysis of the industry to forecast how domestic industry will respond to the AEC formation in 2015. Take steps to prepare the industry for possible increased competition.

- If the export analysis reveals that the industry is an ‘under-achiever’, the country should try to improve the industry’s export performance through proactive policy interventions to capture increased world demand in this dynamic industry.

- It is important to study the sustainability of future demand growth for these dynamic industries. If the growth in demand is found to be short-lived, the country should not invest too many resources into these industries.

- The skill requirements in these industries need to be studied and the national educational institutions must be encouraged to cater to these requirements.

- A detailed industry-specific constraint analysis needs to be conducted and policy measures should be adopted to mitigate these constraints to promote faster industry growth. This is crucial to ensuring that growth policies are not frustrated by an external constraint.

- An industry level value chain analysis needs to be carried out to explore options of producing more value added goods within the industry.

- Organize stakeholder consultations to explore options to minimize the hotspot impact. This usually involves local citizens, government and industry in developing a shared understanding of the specific challenges related to that industry and proposing ways forward.

- The use of global best practices should be encouraged. Leading firms use less water and energy and generate less waste per unit of added value. The government should introduce a programme of learning on best global standards for all growth industries and support programmes to update the skills of local staff to deliver such best practices.

- National governments should consider using local government procurement to support high levels of performance by setting clear environmental and social standards for supply, where such delivery performance is feasible. Government should work with local trade associations to develop these standards. A secondary benefit of such practices can be a reduction of infrastructure demand, and where this occurs, governments may seek ways to support such growth.

- Trade associations and leading firms in the industry should be encouraged to develop a roadmap to lead the industry in achieving global levels of environmental and social performance. Such roadmaps should be endorsed by the government and made public.

4.2.3 'Strong medicine' industries

These are industries that did not emerge as 'economic winners' but passed our 'opportunity screening' and were not near any constraints as defined in our environmental and social analyses.

- Conduct industry-specific and detailed studies to analyse reasons for the weak economic performance.

- Carry out a value chain analysis to determine whether climbing up the value chain can enable the industry to become an 'economic winner'.

- Conduct an 'AEC scenario' analysis of the industry to forecast how domestic industry will respond to the AEC formation in 2015. Take steps to prepare the industry for possible increased competition.

- These industries are important to the country, hence, identify the binding constraints and take policy measures to mitigate these wherever possible.

- If the industry passed the 'opportunity screening' due to its very high export or labour share, identify other possible industries that can act as a possible 'substitute' in future by absorbing the labour currently employed in this industry or by providing export revenue. The ideal strategy is a gradual phasing out of the industry while promoting the growth of 'substitute' industries.

- If the industry passed the 'opportunity screening' on account of being a 'champion in adversity', further checks need to be undertaken to understand why the country is increasing its global export share in an industry with non-dynamic world demand. If it is because all the other competitors are moving out of the industry (due to an impending collapse of the industry), the country should elaborate an exit strategy and stop expanding its export share. On the other hand, if the industry has a sizable global demand that is relatively stable, there is no need for any rash measures and the industry should be encouraged to grow.

- Given that the industry has no identified environmental or social constraints, the potential for seeking a superior value status for its products in international markets must be assessed. Certification schemes or standards offer one route, seeking out OEMs with strict purchasing standards is another, and finally, own-sector export marketing support (explaining the benefits to buyers) is another.

- The potential for developing new 'green' products that benefit from the lack of local negative impacts should be studied. This offers an accelerated pathway towards higher value adding products.

4.2.4 'Double trouble'

These are industries that are 'economic losers' that have passed our 'opportunity screening', but pose some serious environmental or social threats.

- Carry out detailed industry-specific studies to analyse reasons for the weak economic performance.

- Conduct a value chain analysis to determine whether climbing up the value chain can enable the industry to become an 'economic winner'.

- Conduct an 'AEC scenario' analysis of the industry to forecast how domestic industry will respond to the AEC formation in 2015. Take steps to prepare the industry for possible increased competition.

- These industries are usually important to the country, hence, identify the binding constraints and take policy measures to mitigate these binding constraints wherever possible.

- If the industry passed the 'opportunity screening' due to its very high export or labour share, identify other possible industries that can act as a possible 'substitute' in future by absorbing the labour currently employed in this industry or by providing the export revenue. The ideal strategy is a gradual phasing out of the industry while promoting the growth of 'substitute' industries.

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- Industry growth is likely to bring about significant external impacts and costs, which must be fully analysed and agreed before committing to support the industry's growth.

- For such industries it is imperative to understand the position of the local industry compared to international best practice in terms of environmental and social performance. Ways to support the industry while managing the impacts may be identified based on this knowledge – for example, by specifying global standards for water emissions, any new factories can simultaneously improve their know-how and share it with neighbours, as well as reduce external costs.

4.2.5 'Forget' industries

- These industries did not emerge as 'economic winners' and at the same time do not appear to be significant based on our 'opportunity screening' (export share, employment share, political/cultural sensitivity, etc.). Hence, these industries should be allowed to gradually make an exit and do not require much policy attention from government.

4.3 Thematic recommendations for industry

This report has developed a new methodology combining economic performance and environmental sustainability evaluation of industries into a single framework. Achieving the target of sustainable industrial growth requires proactive policy interventions by governments. Though globalization and the emerging spirit of regional integration have rendered some policy tools ineffective, there is still ample scope of policy actions to guide industrial development. According to Lall (2003), the case for industrial policy remains strong and is in fact becoming stronger with technical change and globalization. We divide the policy discussions into the following themes:

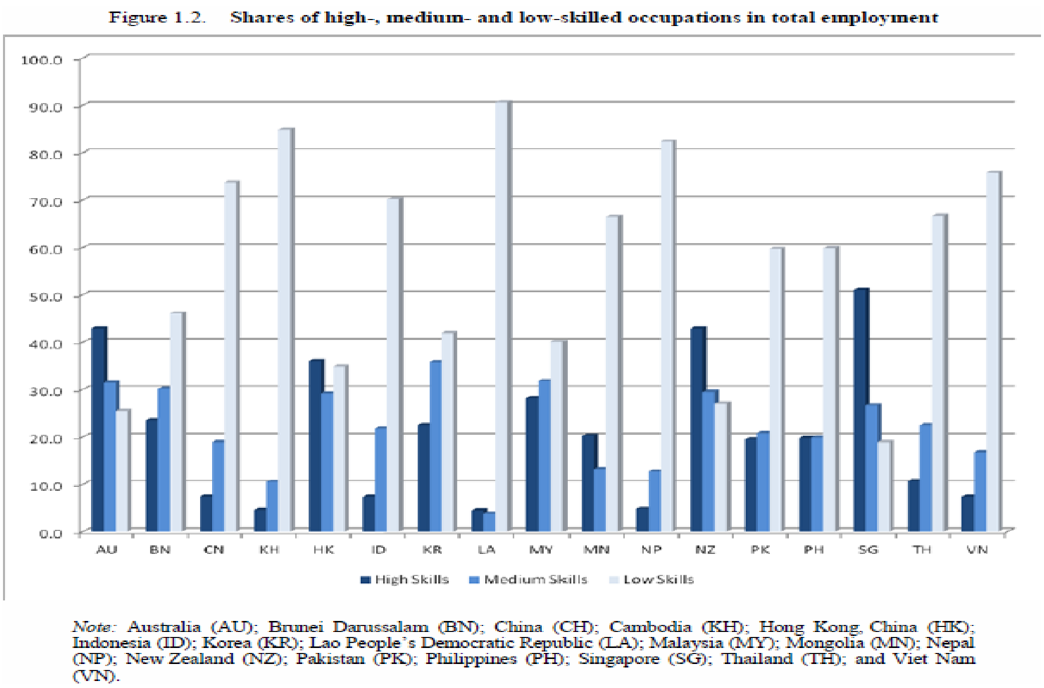
- Skill development
- Industrial deepening and diversification
- Regional focus for industrialization.

4.3.1 Skill development

Several factors play a key role in shaping the industrial competitiveness of a country, but 'ultimately perhaps the most important single determinant is the level and improvement of workforce skills at all levels' (Lall, 1999:2).The ASEAN region hosts over 600 million people, hence, transforming this huge population into a skilled workforce is an opportunity that holds the key to unleashing the region's growth potential. This is not an easy task and requires detailed country- and industry-specific skills analyses and policy actions. Here we only attempt to provide some broad guidelines for policy action.

The section below presents a snapshot of skill distribution in Thailand, the Philippines, Viet Nam, Indonesia and Malaysia compared to some other countries in the region. Malaysia and the Philippines have the highest share of high and medium skilled work force, while Indonesia and Viet Nam have the lowest shares among this group.

Figure 22 Share of high-, medium- and low-skilled jobs in total employment



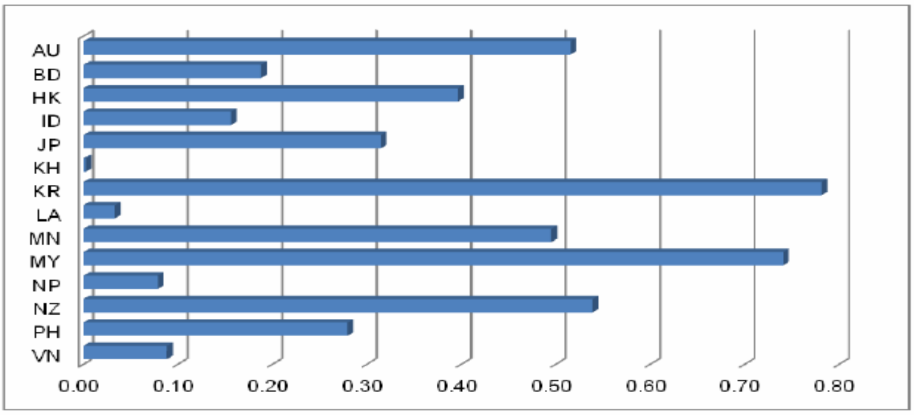
From: Martinez-Fernandez, C. and K. Choi (2012), "Skills Development Pathways in Asia: Employment and Skills Strategies in Southeast Asia initiative (ESSSA)", OECD. Local Economic and Employment Development (LEED), Working Papers, 2012/12, OECD Publishing. http://dx.doi.org/10.1787/5k94hdlll7vk-en. Figure 1.2, page 18

The following figure analyses the percentage of science and engineering graduates as a percentage of the labour force. The percentage of science and engineering graduates in the total labour force is considerably lower in Viet Nam and Indonesia than is the case in the two countries' regional neighbours. The low share of engineering and science graduates is in fact an indicator of the low sophistication of industrial output in these countries.

What impedes unfettered market forces from determining the optimal equilibrium skill supply by matching demand and supply is the time lag that exists in closing the skill gap in each industry. For instance, by the time the educational system meets industry demand for certain skills, it will easily take years for the required number of individuals trained in these skills to become available on the market, but the skill gap may have by then already been met by the firm or the specific work may have already been outsourced. Hence, policymakers need to address this issue from both the supply and demand side to create more skills, higher levels of skills and different types of skills.

Figure 23 Science and engineering graduates as a % of the labour force, 2009

Figure 1.6. **Science and engineering graduates as a % of the labour force, 2009**



Notes: Australia (AU); Brunei Darussalam (BN); Cambodia (KH); Hong Kong, China (HK); Indonesia (ID); Japan (JP); Korea (KR); Lao People's Democratic Republic (LA); Malaysia (MY); Mongolia (MN); Nepal (NP); New Zealand (NZ); Philippines| (PH); and Viet Nam (VN). Data for Australia and New Zealand for 2006; Hong Kong, China for 2004; Viet Nam and the Phillipines for 2008; Nepal for 2010.

Source: Based on graduate statistics from UNESCO, Institute for Statistics, and labour force statistics from ILO (2011), Table 1a.

From: Martinez-Fernandez, C. and K. Choi (2012), "Skills Development Pathways in Asia: Employment and Skills Strategies in Southeast Asia initiative (ESSSA)", OECD. Local Economic and Employment Development (LEED). Working Papers, 2012/12, OECD Publishing. http://dx.doi.org/10.1787/5k94hdlll7vk-en. Figure 1.6, page 25

In the section that follows, we propose some general guidelines and good practices for policy formulation in achieving skill development to promote green jobs.

- To ensure sustainable industrial practices, skill development policy should focus on creating 'green skills', which includes, but is not limited to, training in environmentally efficient manufacturing, modern recycling techniques, renewable energy development, monitoring and assessment and in waste management techniques.

- Skills policy should facilitate the transition from the formal education system (especially higher education) to industries. Internships and 'bridging' programmes should be developed and supported. Students should also be supported in the creation of mixed curricula, including both formal knowledge and practical skills.

- As shown above, there is considerable variation in skill levels in the case countries – with the formation of AEC, each country's skill development policy should have a regional focus. The possibility of tapping into potential skill distribution in the AEC's combined labour force should also be exploited.

- Given the missing link between industries and the education system, in particular universities, skills policy should facilitate dialogue and information flow by providing network services, opening and promoting the visibility of technology transfer offices within universities and enabling joint ventures between public research institutes and private companies through financial support schemes.

- Skills policy should channel increasing public resources to vocational schools and training centres as well as promote experience-based skills development in the education system in general. Vocational schools and training centres develop skills targeted to industry-specific production tasks and therefore seem to offer a more appropriate and selective response to industries' needs and gaps.

- A specific skills gap was identified across industries and countries. Poor control over industrial processes results in more waste and scrap being manufactured, more energy, water and materials being used per unit of value added which strongly affects the ability to deliver more challenging and higher value added products.

- A continuous innovation and skills needs survey should be considered to determine current and future skills needs in industry and beyond.

- Skills development must be in line with short-, medium- and long-term industrial strategies, along with technology foresight.

4.3.2 Industrial deepening and diversification

UNIDO (2009) found that between 1975 and 2005, rapidly growing low and middle income countries diversified their production structures while their slow growing counterparts were less successful in terms of their diversification and sophistication efforts. This fact points to the link between growth and industrial diversification. Hausmann et al. (2007) theoretically and empirically demonstrate that 'what you export matters' to determine the future growth trajectories of countries and 'how specializing in certain products brings more growth than specializing in others'.

Hence, the two factors that will define an industry's successful development are:

1. Production of a more diversified basket of goods and shift towards new product varieties.

2. Improving the level of sophistication and climbing up the value chain within the existing product base.

Consistent inter- and intra-industry dynamism is even more relevant given the context of a possible AEC formation. Finding product varieties and moving to higher value added product lines within the same industry will define the survival criterion for many industries in the face of increased regional and global competition. Sustainability should be a key factor in determining such new product categories. Given the natural resource wealth of the five ASEAN economies included in this study, it is important to create a domestic industrial base to transform these resources into more value added product lines.

To trigger industrial diversification, industrial policy needs to be targeted and selective subsidies for the 'costs of self-discovery' considered (Rodrik, 2004). The provision of subsidies to first movers into new industries combined with clear performance benchmarks and phase-out clauses, can play an important role. For this to be possible, there is a need to identify and target industries and product lines that each country could diversify into in the near future. International market dynamics, competitive pressure, existing technological and human capabilities as well as natural endowments are a few factors that have to be considered in this regard.

We make the following policy recommendations to trigger industrial diversification and deepening:

- Introduce policy measures to facilitate the private sector in identifying new product varieties that could be profitably produced within each country. Given the AEC formation, these identification strategies should incorporate the resources that exist not only within a country but rather across the entire region.

- The government needs to initiate evidence-based dialogue with the private sector to identify the bottlenecks that impede entry into new product varieties, and effective policy measures must be adopted to mitigate such impediments wherever possible.

- 'First mover' subsidies can be considered, provided they are clubbed with clear sun-set clauses and performance benchmarks.

- Some of the new product categories might require trade preference or protection during initial stages; such strategic industrial policy considerations should define the trade policy both within the AEC and with the rest of the world.

- Within the existing product categories, undertake efforts to move into niche high-value products such as 'organic products' or 'free range farm products' which yield much higher export value and cater to high-end markets while being less susceptible to demand fluctuations.

4.3.3 Regional focus on industrialization

As already mentioned, the formation of the AEC has been set as the end goal of regional integration. This will transform the ASEAN into a single market and production base by 2015, while achieving the free movement of goods, services, investment, skilled labour and the freer flow of capital within the region. The industrial policies of each individual member state need to respond effectively to this major transformation in this region.

The formation of AEC will help consolidate expanded market access to all industries in the region, making cheap raw material more accessible and a significant reduction of production costs. This also opens up challenges of increased competition, both from domestic and global counterparts who might view the AEC as a huge potential market. Transforming the AEC into a global powerhouse of industrial production will require strategic industrial policy formulation at both the member state level and for the region as a whole. We offer some policy guidelines to effectively respond to these challenges and to exploit potential opportunities.

- An AEC regional industrial policy must be formulated to transform the region as a whole into an attractive industrial investment destination. Such a regional industrialization policy should also focus on improving both the hard and soft infrastructure that will facilitate industrialization efforts in the region.

- The strategic AEC regional industrial policy should also lay foundations for future trade negotiations with the region's global trading partners.

- Governments, along with industrial associations, should identify goods and product lines in which each country has its comparative and competitive advantage. Full support must be given to the expansion of these industries. The skill development and infrastructure development policies must correspond to the needs of these prospective 'champion' industries.

- Following the formation of AEC, governments, along with industrial associations, should identify domestic industries that might be most vulnerable to external competition and help prepare these industries in their exit process. Retraining and relocation of the labour force in these industries should be a priority policy focus.

- Governments should synchronize domestic industrial policy with the goals and industrial policy of the region as a whole. In certain cases, regional trade agreements have the potential to become more restrictive than WTO rules in terms of the possible range of industrial policies countries have traditionally implemented to generate new productive capacities (Shadlen, 2005). Each country government should be aware of the industrial policy that it will have to give up as a result of the formation of AEC.

- With the prospect of increased foreign investment in the industrial sector, environmental standards and regulations must be clearly defined and strictly enforced at the very early stages to ensure that the region does not become a 'pollution haven'.

5. Conclusions

5.1 Methodology

The ASEAN region is enjoying rapid industrialization with many benefits and looks ahead to a future of sustained growth based on a variety of competitive factors. Effective industrial policy is crucial to support this development with the stated aim of achieving green growth. This report takes this as a starting point and proposes a method to analyse the likely growth industries in each case country, with the aim of conducting an integrated economic, environmental and social analysis to support national and regional governments in identifying the most attractive industries. The methodology does not identify specific policies or actions but determines the specific strengths and weaknesses of industries, which may influence policy choices.

The methodology first assesses the performance of candidate industries by analysing their economic performance to determine which industries align with the respective country's endowment structures and offer dynamic growth potential. The environmental and social assessment is combined to analyse major inputs (materials, water, energy) and outputs (land, water, air), as well as labour conditions. Data on all these dimensions are collected via a desk study and local research, including face-to-face meetings with government, industry and various NGO representatives. Such analyses have been carried out in the past, but require considerable resources and hence have been limited to a small number of industries or sometime even just one. We aim to analyse multiple industries to offer greater comparative data as part of the policymaking process.

The analysis seeks to identify industries that are economically dynamic and that can operate without creating unsustainable environmental and social burdens. Such analyses are technically challenging and we have simplified the analysis of the environmental and social performance by assessing whether growth in a specific industry will bring the country close to its natural limits. This approach can be understood using three different notions: the 'Pareto principle'; the 'proximity principle'; and 'potential value'. For example, an industry with a high demand for energy, such as aluminium smelting, would become problematic for a country that has little energy availability. We refer to this as the 'proximity principle'. For the practical purpose of achieving results within a relatively short time period, we reduced complex data processing as much as possible. We refer to this as the 'Pareto principle.' In contrast to other environment reports, we sought a positive value from industry activities in both environmental and social contexts. We refer to this as 'potential value' or 'hotspots'.

The methodology described here tries to find a practical balance between the clear objective of using well-established and verified data sets for quantitative analysis and the reality that many of those data sets are not yet available. Based on an assessment of the metals and chemicals industries across five ASEAN nations, two distinct industry reports were written: a metals industry report and a chemicals industry report. We believe that critical insights into the green growth potential of specific industries can be drawn from the methodology at a reasonable cost and quality.

There are only few alternatives to conducting an in-depth analysis of an industrial sub-sector. The main problem lies in the lack of environmental data at industrial sub-sectoral level requiring that new data is collected for the analysis. This is a slow and costly process, and is prone to criticism for the methodological choices being made. Yet the selection of priority growth industries without the benefits of such an analysis would defy the concept of sustainable development.

Given the ASEAN region's current development path, it is clear that much industrial development will be achieved which will be influenced by macro and sectoral policies. Policymakers must have the tools to support such crucial decisions about which industries to promote and what the key impacts of such a policy might be. By offering a simple categorization of industries into 'Green growth', 'Growth with care', 'Strong medicine', ‘Double trouble’ and ‘Forget’, it is possible to quickly assist policymakers by elaborating a standard set of actions for that category.

5.2 The future of the methodology

The methodology is deliberately designed to cope with poor quality data that is often qualitative in nature, while still offering robust assessments. Nevertheless, data availability in areas that are often of critical national importance may be poor. This is not only a concern for industrial policymaking, but also for wider environmental and social policymaking, where a quantified understanding of water and material resources may be missing. We therefore recommend this methodology to be used for target industries to immediately identify key potential industries, but also the areas of greatest concern in terms of data gaps. National governments must seek to increase their capability in understanding national capacities as well as their capability in monitoring the actual performance of industry (in many cases, national data on actual performance was not available and calculations were based on predictions drawn up by the firms themselves).

The methodology highlights a further challenge for national and regional governments as the responsibility for industrial policy, energy data, water policy, etc., which resides in different ministries, often with different aims and purposes. The proposed methodology deliberately integrates these and if implementation is to be successful, collaboration between ministries will be a requisite. No proper assessment is possible without understanding the limits of the data being used, which means that data cannot simply be e-mailed to the analyst; instead, the ministry holding the data must not only make the data available, but also fully explain the limits and strengths of that data.

5.3 The future of green growth

The ASEAN region is home to many rapidly developing countries that are attracting or generating various forms of investment. As factories emerge and grow, they bring both economic growth and environmental and social impacts. It is logical for governments to want to grow those industries that offer better economic prospects while not stretching the capacity of the nation to support the industry. Yet typical development pathways frequently exploit national wealth, often in the form of minerals or other natural resources, thus encouraging the growth of industries that are both resource-intensive and low in value added. A careful selection amongst these industries is therefore more important for developing countries that are still building capabilities in national infrastructure.

The methodology we have developed offers both critical and positive insights into the industries studied here and into the institutional capabilities to support them. Few nations and industries offer tremendous ‘green growth’ opportunities, but at the other end of the spectrum, few nations and industries are in the ‘Forget’ category. Many industries appear to offer potential for ‘Growth with care’.

The role of government capability to support green growth is clear – firstly in the need for better data to support policymaking, secondly, in the need for much better monitoring of existing industry, thirdly, in the need for high quality engineers to both improve industry performance and to conduct independent or government monitoring.

The government also plays a critical facilitating role, together with trade associations, to develop a strong understanding of the global benchmarks in efficient use of energy, water, materials and emissions management. We found a small number of globally competitive companies that were locally owned and had a nuanced understanding of economic, environmental and social performance standards. These companies recruit the best staff – often from outside the home nation – and add value more effectively than their sectoral counterparts. They are a clear example that excellence, efficiency and strong environmental performance is possible alongside strong economic performance, and these companies should be encouraged to spread their understanding to non-competing companies.

Appendix 1 Exports – all countries to the rest of the world

Product Code	Product Description	Reporter Name	Partner Name	2000 in 1000 USD	2011 in 1000 USD
15	MANUFACTURE OF FOOD PRODUCTS AND BEVERAGES	All countries	World	271592402	743652915
16	MANUFACTURE OF TOBACCO PRODUCTS	All countries	World	14700750	20109219
17	MANUFACTURE OF TEXTILES	All countries	World	164638262	304078054
18	MANUFACTURE OF WEARING APPAREL; DRESSING AND DYEING OF FUR	All countries	World	127915513	239401210
19	TANNING AND DRESSING OF LEATHER; MANUFACTURE OF LUGGAGE, HANDBAGS, SADDLERY, HARNESS AND FOOTWEAR	All countries	World	64657601	150017667
20	MANUFACTURE OF WOOD AND OF PRODUCTS OF WOOD AND CORK, EXCEPT FURNITURE; MANUFACTURE OF ARTICLES OF STRAW AND PLAITING MATERIALS	All countries	World	59331772	92355200
21	MANUFACTURE OF PAPER AND PAPER PRODUCTS	All countries	World	116924013	194143577
22	PUBLISHING, PRINTING AND REPRODUCTION OF RECORDED MEDIA	All countries	World	44671315	66385792
23	MANUFACTURE OF COKE, REFINED PETROLEUM PRODUCTS AND NUCLEAR FUEL	All countries	World	145146317	729607278
24	MANUFACTURE OF CHEMICALS AND CHEMICAL PRODUCTS	All countries	World	542980548	1.572E+09
25	MANUFACTURE OF RUBBER AND PLASTIC PRODUCTS	All countries	World	133284703	365194479
26	MANUFACTURE OF OTHER NON-METALLIC MINERAL PRODUCTS	All countries	World	71236078	151241818
27	MANUFACTURE OF BASIC METALS	All countries	World	261970955	950907482
28	MANUFACTURE OF FABRICATED METAL PRODUCTS, EXCEPT MACHINERY AND EQUIPMENT	All countries	World	118931310	306428087

29	MANUFACTURE OF MACHINERY AND EQUIPMENT N.E.C.	All countries	World	492535314	1.307E+09
30	MANUFACTURE OF OFFICE, ACCOUNTING AND COMPUTING MACHINERY	All countries	World	322494110	374470651
31	MANUFACTURE OF ELECTRICAL MACHINERY AND APPARATUS N.E.C.	All countries	World	237330372	572651586
32	MANUFACTURE OF RADIO, TELEVISION AND COMMUNICATION EQUIPMENT AND APPARATUS	All countries	World	566910548	946937026
33	MANUFACTURE OF MEDICAL, PRECISION AND OPTICAL INSTRUMENTS, WATCHES AND CLOCKS	All countries	World	184062660	492547680
34	MANUFACTURE OF MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	All countries	World	581174788	1.206E+09
35	MANUFACTURE OF OTHER TRANSPORT EQUIPMENT	All countries	World	198580544	417279695
36	MANUFACTURE OF FURNITURE;MANUFACTURING N.E.C	All countries	World	155001032	355248554
	TOTAL MANUFACTURING	All countries	World	4876070907	11557772387

Appendix 2 Exports – Thailand to the rest of the world

Product Code	Product Description	Reporter Name	Partner Name	2000 in 1000 USD	2011 in 1000 USD
15	MANUFACTURE OF FOOD PRODUCTS AND BEVERAGES	Thailand	World	9433855	30182716
16	MANUFACTURE OF TOBACCO PRODUCTS	Thailand	World	12302.22	16014.39
17	MANUFACTURE OF TEXTILES	Thailand	World	2407275	4328345
18	MANUFACTURE OF WEARING APPAREL; DRESSING AND DYEING OF FUR	Thailand	World	2778519	2577404
19	TANNING AND DRESSING OF LEATHER; MANUFACTURE OF LUGGAGE, HANDBAGS, SADDLERY, HARNESS AND FOOTWEAR	Thailand	World	1704795	1782883
20	MANUFACTURE OF WOOD AND OF PRODUCTS OF WOOD AND CORK, EXCEPT FURNITURE; MANUFACTURE OF ARTICLES OF STRAW AND PLAITING MATERIALS	Thailand	World	577117.9	2022677
21	MANUFACTURE OF PAPER AND PAPER PRODUCTS	Thailand	World	757065.7	3000770
22	PUBLISHING, PRINTING AND REPRODUCTION OF RECORDED MEDIA	Thailand	World	56313.04	4032873
23	MANUFACTURE OF COKE, REFINED PETROLEUM PRODUCTS AND NUCLEAR FUEL	Thailand	World	1631906	10440438
24	MANUFACTURE OF CHEMICALS AND CHEMICAL PRODUCTS	Thailand	World	4360236	22941259
25	MANUFACTURE OF RUBBER AND PLASTIC PRODUCTS	Thailand	World	1961142	11776206
26	MANUFACTURE OF OTHER NON-METALLIC	Thailand	World	1177193	2438390

	MINERAL PRODUCTS				
27	MANUFACTURE OF BASIC METALS	Thailand	World	1313679	9795866
28	MANUFACTURE OF FABRICATED METAL PRODUCTS, EXCEPT MACHINERY AND EQUIPMENT	Thailand	World	1087291	4984644
29	MANUFACTURE OF MACHINERY AND EQUIPMENT N.E.C.	Thailand	World	3451347	17691094
30	MANUFACTURE OF OFFICE, ACCOUNTING AND COMPUTING MACHINERY	Thailand	World	8769068	15310625
31	MANUFACTURE OF ELECTRICAL MACHINERY AND APPARATUS N.E.C.	Thailand	World	3675369	9517948
32	MANUFACTURE OF RADIO, TELEVISION AND COMMUNICATION EQUIPMENT AND APPARATUS	Thailand	World	11247572	19634130
33	MANUFACTURE OF MEDICAL, PRECISION AND OPTICAL INSTRUMENTS, WATCHES AND CLOCKS	Thailand	World	1126981	4507578
34	MANUFACTURE OF MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	Thailand	World	2418723	18800403
35	MANUFACTURE OF OTHER TRANSPORT EQUIPMENT	Thailand	World	472887.9	4894932
36	MANUFACTURE OF FURNITURE; MANUFACTURING N.E.C	Thailand	World	3200616	8387425
	TOTAL MANUFACTURING	Thailand	World	63621253	209064619.2

Appendix 3 Hotspots and coolspots of social aspects[4]

No.	Hotspots/ Coolspots	Category	Reference
1	Hotspots/ Coolspots	Potential of minimum wage not being updated	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
2	Hotspots/ Coolspots	Potential of country not passing labour laws	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
3	Hotspots/ Coolspots	Potential of country not adopting labour conventions	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
4	Hotspots/ Coolspots	Potential of average wage being < minimum wage	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
5	Hotspots/ Coolspots	Potential of average wage being < non-poverty guideline	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
6	Hotspots/ Coolspots	Percent of population living on < US$ 2/day	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
7	Hotspots/ Coolspots	Risk of child labour	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
8	Hotspots/ Coolspots	Risk of forced labour	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
9	Hotspots/ Coolspots	Percent of population working >48 hours/week	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
10	Hotspots/ Coolspots	Risk of not having freedom of association rights	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
11	Hotspots/ Coolspots	Risk of not having collective bargaining rights	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
12	Hotspots/ Coolspots	Risk of not having the right to strike	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
13	Hotspots/ Coolspots	Overall fragility of legal system	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
14	Hotspots/ Coolspots	Number of indigenous population	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
15	Hotspots/ Coolspots	Risk of country not adopting indigenous ILO Convention and UN Declaration	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
16	Hotspots/ Coolspots	Risk of country not passing laws to protect indigenous population	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
17	Hotspots/ Coolspots	Potential for high conflict	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)

[4] In social aspects, the improvement of social hotspots becomes social coolspots.

18	Hotspots/ Coolspots	Overall fragility of gender equality	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
19	Hotspots/ Coolspots	Number of children out of school - male	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
20	Hotspots/ Coolspots	Number of children out of school – female	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
21	Hotspots/ Coolspots	Number of children out of school - total	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
22	Hotspots/ Coolspots	Risk of not having access to improved drinking water – rural	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
23	Hotspots/ Coolspots	Risk of not having access to improved drinking water – urban	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
24	Hotspots/ Coolspots	Risk of not having access to improved drinking water – total	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
25	Hotspots/ Coolspots	Risk of not having access to improved sanitation - rural	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
26	Hotspots/ Coolspots	Risk of not having access to improved sanitation – urban	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
27	Hotspots/ Coolspots	Risk of not having access to improved sanitation - total	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)
28	Hotspots/ Coolspots	Risk of not having access to a hospital bed	(Benoît-Norris, 2013, Benoît-Norris et al., 2011)

Appendix 4 Hotspots and coolspots of environment

No.	Hot spots	Category	Reference
1	Hotspots/Air emission/Chemical	VOCs, CO, HAPs	(Graedel and Howard-Grenville, 2005)
2	Hotspots/Air emission/Chemical	Sulphur dioxide	(Graedel and Howard-Grenville, 2005)
3	Hotspots/Air emission/Chemical	Nitrogen oxides	(Graedel and Howard-Grenville, 2005)
4	Hotspots/ Water/Chemical	Reactants	(Graedel and Howard-Grenville, 2005)
5	Hotspots/ Water/Chemical	Impurities	(Graedel and Howard-Grenville, 2005)
6	Hotspots/ Water/Chemical	Reagents	(Graedel and Howard-Grenville, 2005)
7	Hotspots/ Water/Chemical	Hydrocarbons	(Graedel and Howard-Grenville, 2005)
8	Hotspots/ Water/Chemical	Catalysts	(Graedel and Howard-Grenville, 2005)
9	Hotspots/ Water/Chemical	Additives	(Graedel and Howard-Grenville, 2005)
10	Hotspots/ Water/Chemical	Resins	(Graedel and Howard-Grenville, 2005)
11	Hotspots/ Water/Chemical	Cleaning agents	(Graedel and Howard-Grenville, 2005)
12	Hotspots/ Water/Chemical	Hazardous organic chemicals	(Graedel and Howard-Grenville, 2005)
13	Hotspots/ Water/Chemical	Sludge	(Graedel and Howard-Grenville, 2005)
14	Hotspots/Air emission/Metal	SO_2	(Graedel and Howard-Grenville, 2005)
15	Hotspots/Air emission/ Metal	H_2SO_4	(Graedel and Howard-Grenville, 2005)
16	Hotspots/Air emission/ Metal	CF_4	(Graedel and Howard-Grenville, 2005)
17	Hotspots/Air emission/ Metal	VOCs (carcinogens, photochemical smog)	(Graedel and Howard-Grenville, 2005)
18	Hotspots/Air emission/ Metal	PAHs (toxins)	(Graedel and Howard-Grenville, 2005)
19	Hotspots/Water/ Metal	Hazardous waste water emissions (cyanide, process oils)	(Graedel and Howard-Grenville, 2005)
20	Hotspots/Water/ Metal	Hazardous waste water emissions (metal shaving)	(Graedel and Howard-Grenville, 2005)
21	Hotspots/Water/ Metal	Hazardous waste water emissions (plating solutions)	(Graedel and Howard-Grenville, 2005)
22	Hotspots/Water/ Metal	Hazardous waste water emissions (cutting oils)	(Graedel and Howard-Grenville, 2005)

23	Hotspots/Water/ Metal	Solid waste (rich in chemicals, especially casting sand)	(Graedel and Howard-Grenville, 2005)
24	Coolspots/Symbiosis/ Metals	SO_2 + limestone = gypsum; Flue-gas desulfurization residue for gypsum	(Ritchey et al., 1998)
25	Coolspots/Symbiosis/ Metals	$CO + 2H_2$ = methanol	(Árnason and Sigfússon, 1999)
26	Coolspots/Symbiosis/ Metals	Reform coke oven gases to Syngas	(Johansson and Söderström, 2011)
27	Coolspots/Symbiosis/ Metals	Metal symbiosis plan: 4 carbon steel mills, 1 stainless steel mill, 1 zinc plant & 1 iron regeneration plant. The dust, scales and sludge from steelmaking could be fed into a regeneration plant to produce iron and zinc. The waste product jarosite from the zinc plant could be processed by fuming off zinc and other volatile materials and the resulting slag used for construction. The manganese dregs resulting from zinc production could be used in stainless steel production	(Salmi et al., 2012)
28	Coolspots/Symbiosis/ Metals	Blast furnace slag for cement mix	(Koros, 2003, Tüfekçi et al., 1997, Maslehuddin et al., 2003)
29	Coolspots/Symbiosis/ Metals	Use of ferric & non-ferrous sulphate from steel industry for animal feed, fertilizers, etc.	(Onita, 2006)
30	Coolspots/Reuse waste as input on site/Metals	Reuse SO_2 in metal casting operations	(Barnett, 1999)
31	Coolspots/Reuse waste as input on site/Metals	Reuse foundry sand	(Graedel and Howard-Grenville, 2005)
32	Coolspots/Reuse waste as input on site/Metals	Use iron scrap as steel input	(Koros, 2003, Pollack and Bradsher, 2004)
33	Coolspots/Reuse waste as input on site/Metals	Reuse iron-bearing waste oxides which replaces iron pellets and additional chemicals	(AISI, 1993)
34	Coolspots/Reuse waste as input on site/Metals	Reuse combustion gases to reduce energy consumption	(Wajer et al., 2007)
35	Coolspots/Reuse waste as input on site/Metals	Reuse rinse baths; US$ 4,500 /year	(NCDENR, 1996)
36	Coolspots/Reuse waste as input on site/Metals	Clean and reuse process oils	(NCDENR, 1997c)
37	Coolspots/Reuse waste as input on site/Metals	Electric Arc Furnace (EAF) dust metals recovery	(U.S.EPA, 2008)

38	Coolspots/Reuse waste as input on site/Metals	130,000 tons of steel slag used in place of limestone (single plant operation)	(Onita, 2006)
39	Coolspots/Reuse waste as input on site/Metals	Electricity production through CHP	(Johansson and Söderström, 2011)
40	Coolspots/Green Chemistry/Metals	Use of copper pyrophosphate instead of copper cyanide; replace chromium plating with nickel-tungsten-boron plating.	(Dini and Steffani, 1996)
41	Coolspots/Green Chemistry/Metals	Use of regenerative catalytic oxidizer (RCO) that decomposes hazardous air emissions and operates at 200^oC instead of 600^oC	(Rasmussen et al., 2006)
42	Coolspots/Green Chemistry/Metals	Nitric acid stripping solution replaced by hydrogen peroxide, eliminating nitric acid hazardous waste; US$ 7,000 /year	(NCDENR, 1995a)
43	Coolspots/Green Chemistry/Metals	Increase ore purity to use less chemicals and less hazardous emissions	(Graedel and Howard-Grenville, 2005)
44	Coolspots/Green Chemistry/Metals	Ionic liquids as solvents (green chemistry-generic) unreactive to air and moisture	(Scionix, 2004)
45	Coolspots/Chemicals Management/Metals	Sell waste oil from processes to a processing company; the company sells it as automotive lubricant or to cement kilns as fuel	(Al-Omari, 2008, Doyle and Pearce, 2009, U.S.EPA, 2008)
46	Coolspots/Symbiosis/ Chemicals	Use of a by-product (ammonium sulphate) as an input to other industrial processes	(Anastas et al., 1999)
47	Coolspots/Symbiosis/ Chemicals	Sulphuric acid (by-product) as input in ore purification; ammonium sulphate (by-product) used in farm (US$ 15,0000 /year)	(NCDENR, 1997a)
48	Coolspots/Reuse waste as input on site/Chemicals	Use of hydrogen (by-product chlor-alkali production) to produce electricity; recovered 20% of energy consumed by the facility	(Mah et al., 1999)
49	Coolspots/Reuse waste as input on site/Chemicals	Flash steam recovery from heaters US$ 5,400 /year	(Wajer et al., 2007)
50	Coolspots/Reuse waste as input on site/Chemicals	Reduced energy demand by better use of chillers; US$ 900,000 /year	(Wajer et al., 2007)
51	Coolsposts/Green Chemistry/Chemicals	New process for water treatment that eliminates oil to dissolve monomer in solution of innocuous ammonium sulphate and polymerizes it with a small	(Anastas et al., 1999)

		amount of initiator	
52	Coolsposts/Green Chemistry/Chemicals	Use of regenerative catalytic oxidizer (RCO) that decomposes hazardous air emissions and operates at 200°C instead of 600°C	(Rasmussen et al., 2006)
53	Coolsposts/Green Chemistry/Chemicals	Novel method to carry out a variety of important chemical reactions that had previously required both an oxygen-free atmosphere and hazardous organic solvents. The reactions use metal catalysts and run in open containers of water. This method is inherently safer, requires fewer process steps, operates at lower temperatures, and generates less waste.	(Li, 2002)
54	Coolspots/Green Management/Chemicals	Ford – Dupont	(Ehrenfeld, 2001)
55	Coolspots/Green Management/Chemicals	3M Twist 'n Fill cleaning chemicals management system	(3M, 2013)
56	Coolspots/Green Management/Chemicals	Dow chlorinated solvents management	(DOW, 2013)
57	Coolspots/Green Management/Chemicals	Services: control acquisition, delivery, storage, application, disposal; targets -> reduce chemical use, purchasing cost, process efficiency. A steel automotive related industry saved US$ 1,5 m in 4 years.	(Quaker, 2013)
58	Coolspots/Symbiosis/ Electronics	Piping of the 2800 megawatts of heat generated by the data centre to the local public swimming pool	(Turton, 2008)
59	Coolspots/Reuse waste input on site/Electronics	Recycle and re-use solvents used for equipment cleaning and line flushing are recycled on site with a solvent distillation unit	(NCDENR, 1995b)
60	Coolspots/Reuse waste input on site/Electronics	Recover and reuse chemicals from electroless plating operation. Sodium hydroxide and formaldehyde are added to the plating bath overflow to recover the copper, which is then dissolved for reuse by a sulfuric acid/hydrogen peroxide solution	(U.S.EPA, 1990)
61	Coolspots/Reuse waste input on site/Electronics	Recycle and re-use process water	(Graedel and Howard-Grenville, 2005)
62	Coolspots/Reuse waste input on site/Electronics	Reduce water consumption and preserve natural resources while simultaneously reducing water-related costs: filtration and reuse	(Seliger, 2007)

		of treated effluent in industrial process and toilets. Benefit US$ 68,000 /year	
63	Coolspots/Green Chemistry/Electronics	Replace solvent-based varnishes with water reducible varnishes, thus removing a hazardous waste stream	(NCDENR, 1995b)
64	Coolspots/Green Chemistry/Electronics	Convert to new flux systems with non-VOC solvent systems and inactive residues; US$ 210,000 /year	(NCDENR, 1997b)
65	Coolspots/Green Chemistry/Electronics	Develop a new process in which a chlorine-free silicon fluid is used as a raw material. With replacement of silicon tetrachloride raw material by the silicon fluid, no hydrochloric acid by-product is generated. This modification eliminated all hydrochloric acid and chlorine gas emissions from the glass manufacturing process. Benefit US$ 30,0000 /year	(NCDENR, 1995c)
66	Coolspots/Green Chemistry/Electronics	Replace the chromic acid with phosphoric acid. Benefit: US$ 3,100 /year	(WARP, 1998)

Appendix 5 Interview questionnaire

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO)
Questions for leading company in specific manufacturing sectors

Thank you for taking the time to help us with our project on "Sustainability assessment of industrial sectors: A methodology development for policy recommendations to ASEAN countries." For further information on the project, please refer to the last page of this document.

We look forward to interviewing you on this important subject. To help the interview we are sending you our starter questions that we will use plus a list of the data we are trying to collect. If you wish, you can use this to prepare for the interview by reading the questions. We would welcome any direct figures you can provide.

Confidentiality of the information provided

This survey is designed and conducted by the United Nations Industrial Development Organization (UNIDO). Any information provided in this survey will remain strictly confidential with UNIDO. Data collected will be used for analysis and published at the aggregate level only. **Individual responses will not be identified** but should we want to use a direct quote, you will be contacted for permission.
To facilitate our analysis, we would like to record the interview.

1. Briefly tell us about your company

In every single country, each sector experiences a birth stage, followed by sustained growth, full maturation and eventually a decline.

1. Where do you think your sector is in this life cycle?
2. What is the evidence to demonstrate this?
3. What does the sector need to sustain its growth?

How do they move up value chain?

4. How do you see the evolution of your sector in the next 5-10 years?
5. As regards to supplies, labour, capital, regulations, technology, knowledge, infrastructure, others, at national and international level, what are the
   - Challenges
   - Threats
   - Opportunities
6. What new sectors do you see to be emerging in this country for the next 5-10 years?
7. Why do you think your company has been successful today & can this continue?

National protection? Subsidies? Technology? Low cost?

8. If you have mainly been competitive on price in the past, what do you have to be good at in the future to win business?

9. How important are exports for your company's future?
10. How should the sector take advantage of the regional opportunities?
11. How can the government better support the sector in the next 5 years?

(After the interviewee finished, provide the following list of causes and discuss them, provided they were not brought up by an interviewee)
Educations

Skills
Infrastructure
Export support
Quality control, standardization support
Fiscal & regulatory regime

12. What are the most important aspects of this regional agreement for the company's business operations?
13. In what ways is the growth of your sector held back by the supply chain performance?
14. How relevant are international certifications to a company?
15. Are the cost of energy, water & material costs and the cost of managing your waste, wastewater and emissions to air becoming significant? If yes, how do you plan to keep them low?

Equipment for processing or filtering waste
Improved efficiency equipment
Improvements to product design or specification to win new customers

16. At what level in the company is responsible for managing energy, water, material consumption and waste
17. How do you learn about environmental best-practices?

environmental or social benchmarks
best practice forums

18. What according to you are the greatest barriers to investing in environmental projects?

Total resources/material costs are small and/or are a small percentage of production costs
Top management is not focused on environmental projects
There is insufficient expertise in the plant to identify, develop and implement environmental projects
Fear that environmental projects may cause production interruptions
Equipment is old but still operating effectively – replacement is not cost effective
Difficulty in obtaining external financing for environmental projects
Have other resources investment priorities
Insufficient internal capital
Lack of information/poor quality information on environmental opportunities
Existing policies are inadequate to promote and support environmental projects in industry
Improvement of our resources/material efficiency, does not result in energy costs savings
environmental projects have long payback period

19. Which of the following support services at no cost to your company would be of significant value in deciding to invest in improved environmental management and environmental projects?

Awareness programs on environmental management and efficiency for top management
Environmental audit and identification of resources/material saving projects
Financial and technical appraisal of environmental projects
Assistance in packaging projects for loan applications
Environmental management support and training
Technical training of company personnel
Financial training of company personnel
Information on environmental technologies and practices across your sector
Information on equipment vendors and environmental services suppliers
Project implementation management and support
Availability of benchmarks
Availability of environmental management implementation guidance

20. What are the major negative environmental and social impacts that your sector has?
21. Are these different from the global hotspots (the biggest environmental and social impacts) for your sector?
22. Please read the list of National Constraints. For each constraint below comment on how close you feel the Country is to reaching its limit.
    - Greenhouse Gas Emissions
    - Other hazardous Emissions to air
    - Waste Water produced
    - Solid Waste generated
    - Energy used in manufacturing
    - Water used in manufacturing
    - Raw material used in manufacturing

23. What do the constraints imply for your company and/or your sector?

24. Best practioners globally have found ways to gain value through better environmental or social performance. How relevant is this to your sectors future?

Valorising waste – e.g. selling your waste
Providing superior product performance – e.g. fair trade or bio

25. What national support would most help to improve environmental and social performance in your sector?

26. What are the best examples of success in your company and/or your sector in the last 5 years?

27. What are the greatest future environmental and social opportunities for your company and/or sector?

Background and rationale for methodology development

The United Nations Industrial Development Organization (UNIDO) is a specialised UN agency that promotes industrial development for poverty reduction, inclusive globalization and environmental sustainability. Its mandate is to promote and accelerate sustainable industrial development in developing countries and economies in transition Today, the Organization is recognized as a highly relevant, specialized and efficient provider of key services in support of the interlinked challenges of reducing poverty through productive activities, promoting the integration of developing countries in global trade through trade capacity building, fostering environmental sustainability in industry, and improving access to energy.

If we want a sustainable and economically viable future, we need to ensure our industry does not harm the environment. UNIDO helps developing countries to secure resource-efficient low-carbon growth. This creates new jobs while protecting the environment.

As an organisation, we therefore need tools and methodologies to assess the economic, environmental and social sustainability of industrial sectors when advising member states on their industrial policies. It is with this in mind that we are developing this methodology, and testing it in selected countries of the ASEAN community, namely Malaysia, Thailand, Indonesia, Philippines and Viet Nam.

Over the past decades, globalisation and industrial development have facilitated high economic growth in several emerging countries in the ASEAN region. Since 1990, the region's GDP has grown more than 5% annually much faster than the world's average of around 3%. Unfortunately, this economic growth came coupled with a rapid rise in energy demand, high natural resources use, as well as a degradation of the state of the environment. This needs to be taken into account when formulating future development plans for the region.

Based on this newly developed and tested sustainability assessment methodology, policy recommendations will be made to the ASEAN secretariat, in time for the 2013 summit, when key decisions of the ASEAN post 2015 plan will be made.

Should you need any further clarification, please feel free to contact us by e-mail or by phone. To verify information about UNIDO and the Development Policy, Statistics and Research Branch, please visit the website http://www.unido.org/index.php?id=o182630.

Constraint questions usable when meeting government officers:

- What are your National Kyoto Protocol targets on GHG? What percent ahead/behind your target you are?
What percentage contribution is attributed to manufacturing and to the specific sectors?

- What is the estimated amount of hazardous and toxic air emissions in your country?
What percentage contribution is attributed to manufacturing and to the specific sectors?

- What is the estimated amount of water effluent in your country?
What percentage contribution is attributed to manufacturing and to the specific sectors?
What is the planned future capacity?
What are the regional variations in capacity?
What are the seasonal variations in capacity?
What plans are there to benefit from industrial symbiosis? (encouraging on-site re-use

and/or processing; encouraging load-integration and load-sharing among proximate manufacturers)

- What is the estimated amount of solid waste in your country?
What percentage contribution is attributed to manufacturing and to the specific sectors?
What is the estimated solid waste yearly capacity of your country according to the waste management plan?

- What is the estimated amount of energy produced in your country yearly?
What percentage contribution is attributed to manufacturing and to the specific sectors?
What is the percentage contribution of renewable energy?
What is the planned future capacity?

- What is the estimated amount of Raw Material (grown and mined) produced in your country yearly?
What percentage contribution is attributed to manufacturing and to the specific sectors?
What is the planned future capacity?

- What is the estimated amount of recycled material produced in your country yearly?
What percentage contribution is attributed to manufacturing and to the specific sectors?
What is the planned future capacity?

- What is the estimated amount of available fresh water in your country?
How much water your country consumes yearly?
What percentage contribution is attributed to manufacturing and to the specific sectors?
What is the planned future capacity?
What are the regional variations in capacity?
What are the seasonal variations in capacity?
What plans are there to benefit from industrial symbiosis? (encouraging on-site re-use and/or processing; encouraging load-sharing among proximate manufacturers)
Which sectors could be favoured in which locations?

- Which of the above mentioned constraints (GHG, air emissions, waste water, solid waste, energy used, water used and raw material) is the most important for you? Are there any other constraints not mentioned above, if yes name it.

List of typical ministries to be interviewed

- Ministry of Energy
- Ministry of Natural Resources
- Ministry of Industry
- Ministry of National Planning Economic Development
- Ministry of Environment & Forests
- National Statistics Office
- Department of Health and Safety at Work
- Department of Water Affairs
- Department of Power
- Department of Waste Management
- Regional Water Authorities
- Regional Waste Authorities
- Local NGOs

Appendix 6 How to organize the forum with private sector associates

Pre-forum phase

Step 1 To understand local industry situation and context

Step 2 To hire local consultants for contacting an industry association and arranging forum venue

Step 3 To contact an industry association for a forum

Step 4 To ask a help inviting senior people from major companies and SMEs, respectively

Step 5 To attempt to avoid inviting government people or press (media) people

Step 6 To rent convenient a venue for a forum

Step 7 To discuss a forum time with the local industry associations

At Forum

Step 8 To prepare the forum venue

Step 9 To give a greeting speech by a local UNIDO director

Step 10 To introduce fire exits of the venue and other safety issues

Step 11 To explain objectives of the forum

Step 12 To introduce the forum schedule, methods and no revelation of interviewees

Step 13 To show the results of economic analysis to forum attendants

Step 14 To ask environmental hotspots of the industry for the country and local region

Step 15 To ask social hotspots of the industry for the country and local region

Step 16 To ask environmental coolspots of the industry for the country and local region

Step 17 To ask social coolspots of the industry for the country and local region

Step 18 To ask industry's efforts and challenges to fulfil their plans

Post-forum

Step 19 To do further in-depth interview, if needed

Step 20 To match interview findings with other information

Step 21 To share the results of forums

Step 22 To send the publications researched based on the forum to forum attendants

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