A STUDY ON KNOWLEDGE CONTENT IN KEY ECONOMIC SECTORS IN MALAYSIA PHASE III (MYKE III) – FINAL REPORT (PHASE 2)

A STUDY ON KNOWLEDGE CONTENT IN KEY ECONOMIC SECTORS IN MALAYSIA

PHASE III (MYKE III)

FINAL REPORT (PHASE 2)

NOVEMBER 2016

EPU
ECONOMIC PLANNING UNIT
PRIME MINISTER'S DEPARTMENT, MALAYSIA

MONASH University
MALAYSIA

MONASH University | MALAYSIA

FINAL REPORT – PHASE 2

A STUDY ON KNOWLEDGE CONTENT IN KEY ECONOMIC SECTORS IN MALAYSIA

PHASE III

(MYKE III)

Confidential

30 November 2016






BUSINESS



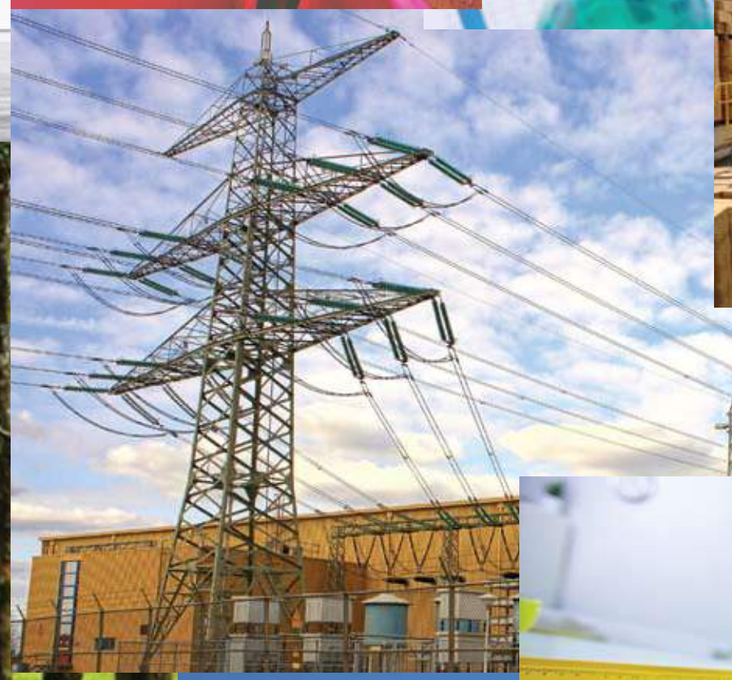






Table of Contents

Executive Summary

The global economy is undergoing rapid changes due to forces of *globalisation, liberalisation* (the opening of markets), regionalisation (trading blocs) and digitisation (converging technology platforms). These forces have intensified competition for resources, talent and markets. Increasingly, wealth creation in this dynamic global economic environment is dependent on the ability of industries to move up the knowledge and innovation value chain. In 2002, Malaysia launched the *Knowledge Economy Master Plan*; and in subsequent 5 year economic plans, significant resources were channeled into transforming the various economic sectors and industries to be more information-intensive and knowledge-driven.

To measure the level of knowledge content of Malaysian industries the *Knowledge Content in Economic Sectors Phase III* (MYKE-III) Phase 2 was conducted over the period from 2015 to 2016. The study was conducted for the following industries: Agriculture (Palm oil, Plant crops, Forestry, Fishery, and Livestock); Electronics and Electrical (Components and Final Products); Food processing; Machinery & instruments; Chemical, Petroleum and Pharmaceuticals; Rubber and Plastics; Wholesale and Retail; and Business Services (Business Development and Technical Services).

This study uses a novel knowledge ecosystem model to assess the state of development of the knowledge ecosystems for the industry, which includes assessing the level of knowledge content and its contribution to economic outcomes. The proposed knowledge ecosystem model consists of the following broad components: *Knowledge Enablers* (Basic Skills Development; Market Intelligence; Institutions – Government, Trade Associations and Universities; Science & Technology Knowledge; Advanced Skills Development; and Knowledge Culture in organisation); *Dynamic Capabilities* (Absorptive capability; Adaptive capability; and Innovative capability); Process Improvement, Product market outcomes and Economic outcomes (productivity, profits, sales, return on investment and market share).

Qualitative and quantitative research methods were used for the MYKE-III (Phase 2) study. For qualitative analysis, focus group and interviews of industry captains, trade association leaders and senior officials from various government agencies were undertaken. In the case of quantitative analysis, a sample of 4438 sample respondents were obtained from Department of Statistics, Malaysia.

A detailed analysis of the knowledge ecosystem of each of the industries revealed that there are key strengths that enable the industries to build dynamic capabilities and knowledge content. Among the key strengths include the following:

- The industries receive strong support from the Malaysian government to become technology- and knowledge-intensive through provision of various fiscal and non-fiscal incentives.

- Significant resources are channeled from the nation's annual budget for education and training. There are more than 600 colleges, universities colleges, universities and training institutes that provide academic and skills development programs for the work force in Malaysia.

- Several public and private universities and GRIs have been established to undertake R&D and develop innovations that are important for industries.

- There is a number of large local players; some of which undertake significant R&D activities to enhance the quality and quantity of products and services.

- The cost of labour and living in Malaysia is relatively cheaper than other developed countries. Malaysia also has access to a large pool of cheap foreign labour from neighbouring countries that keeps the cost of production low compared to other regional players.

- Malaysia has one of the largest English speaking populations within the ASEAN region after Singapore. This, coupled with other attractive incentives for foreign MNCs to relocate their operations to Malaysia, has resulted in a steady flow of foreign direct invest (FDI) into the country. This has resulted in a significant spill-over impact on access to technology, expertise and knowledge for local firms.

- Malaysia is rich in natural resources. Additionally, the tropical climate in Malaysia is an important dimension of the cultivation of key cash crops that are major revenue earners for the country and a source of employment for a large segment of the population.

The knowledge ecosystems for the Malaysian industries were compared with their counterparts from more developed countries, and were found to be comparatively weaker than that of more advanced countries. This suggests that local firms in these industries have not fully optimised the resources and opportunities available to raise their knowledge content and global competitiveness. The common challenges that hinder these industries from transitioning to a knowledge-intensive and innovative-driven industries are outlined below:

- Attracting and retaining workers with basic skills and competencies has been a challenge for many industries. The firms are also unable to attract and retain creative talent. Shortage of talent with advanced skills, specialist expertise and mentors results in the high cost of training.

- Weak technical education and training ecosystem, hence firms are unable to translate absorptive capability into adaptive and innovative capabilities.

- Mismatch between the skillset available and the needs of a fast changing industrial landscape.

- Most industries do not undertake fore-sighting and visioning; hence, firms do not have clear plans to 'future-proof' the development of their industries or mitigate the adverse impact of global forces and uncertainties on their business operations.

- A majority of firms tend to release products and services to the market without developing the foundational and driver conditions of the ecosystem; hence they experience high failure rates and inherit a reputation of producing 'inferior' or 'imitation' products.

- Firms do not invest in the appropriate technology and people to enable them to generate good market Intelligence; hence firms tend to be reactive in their strategic approach and focus on short-term economic perspective.

- Weak institutional framework leads to uncoordinated strategies; this tends to create a high level of bureaucracy, reducing efficiency and increasing the cost of doing business.

- While a significant level of financial resources is provided by the Malaysian government for R&D, the level of R&D by the corporate sector in Malaysia is relatively low compared to that found in more advanced countries. The local R&D ecosystem is also plagued by a lack of strategic focus, weak linkages between key stakeholders and a poor knowledge sharing culture.

To raise the level of knowledge content and competitiveness of the local industries, seven major strategic thrusts are proposed in this report as outlined below.

- *Strategic Thrust 1*: Knowledge Environment - an alignment of policies and strategies to global industry trends, standards and best practices.

- *Strategic Thrust 2*: Knowledge Institutional Systems - develop and optimize the industry ecosystem by focusing on the development of robust institutional systems that enable all stakeholders to develop, manage and implement key programs in a timely manner; so as to ensure that knowledge enablers raise the dynamic capabilities of local firms.

- *Strategic Thrust 3*: Knowledge Approach - adopt a knowledge approach (strategic outlook) that stresses innovation as a fundamental part of the organization's strategy;

- *Strategic Thrust 4*: Knowledge Capital – develop a holistic and sustainable skills and talent strategy to help drive innovation strategies in the industries.

- *Strategic Thrust 5*: Knowledge Competencies - develop a deep understanding of the strategic evolution of the industry, including the associated technological, market and socioeconomic dynamics. Core competencies for the various education and training programs must be clearly mapped, monitored and refined to ensure these programs meet the needs of a rapidly changing industrial structure.

- *Strategic Thrust 6*: Knowledge Learning and Transfer - knowledge transfers must be managed and not left to chance processes. This can be orchestrated through various programs, such as the Fraunhoffer and Steinbeis.

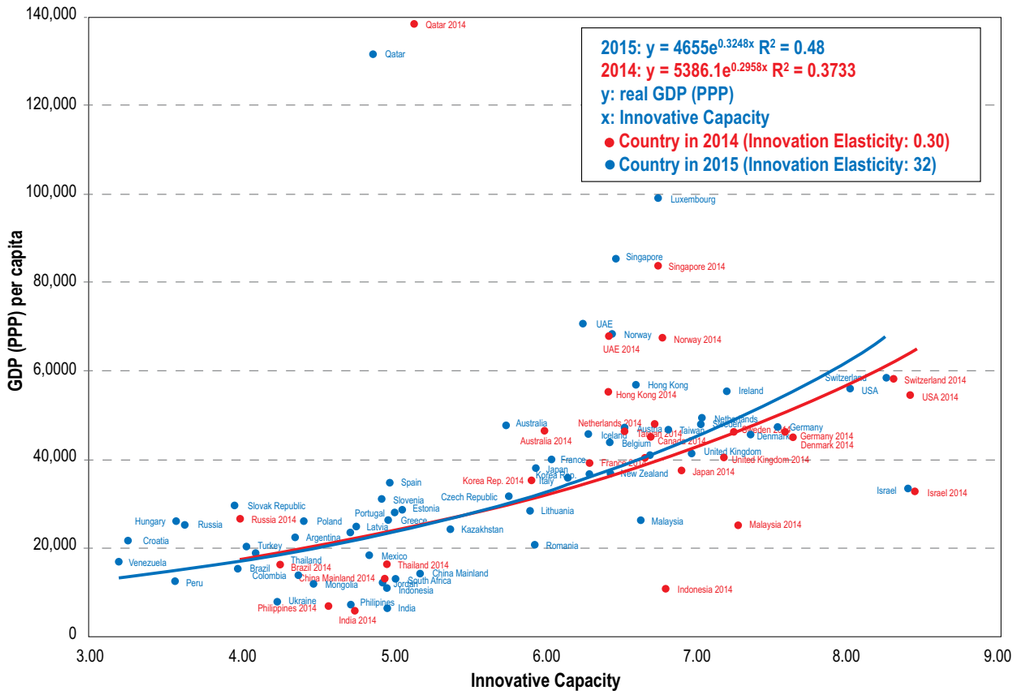
- *Strategic Thrust 7*: Knowledge Leverage - knowledge needs to be shared and used to create a multiplier effect within and across the different industrial ecosystems. This can be achieved through the establishment of "one-stop" portal or agencies that play a key role as a resource center for firms in the industry.

In summary, the MYKE-III (Phase 2) captures the state of development of the knowledge ecosystems for the above-mentioned industries. The study identifies strengths and weaknesses in the ecosystems, providing also recommendations to strengthen the knowledge enablers of the ecosystem, resulting in the industries raising their dynamic (absorptive, adaptive and innovative) capabilities. Higher levels of dynamic capabilities will enable the industries to enhance process improvement and product market development. This will raise the competitiveness of Malaysian industries and economy, boosting her global position.

CHAPTER 1
Introduction

Knowledge is widely recognised as a key source of competitive advantage and wealth accumulation in the new economy (Arrow, 1962, Lucas, 1988 and Romer, 1990). Knowledge is a key factor not only to increase the reach of products, services and markets; but also to enhance the richness of production processes and production output. Countries that have invested in developing their knowledge ecosystems are able to pursue economies of scale with considerable scope. Figure 1.1 show that countries with a higher innovative capacity tend to have higher wealth (measured by taking the per capita income of a country). The innovation elasticity in 2014 was approximately 0.30; while in 2015 was 0.32. This suggests that a 1% increase in innovative capacity will have raised the income by 0.30% in 2014; but will have increased the income by 0.32% in 2015. This suggests that the contribution of innovation on income has increased from 2014 to 2015, implying that more countries are investing in developing and upgrading their national innovation ecosystems (NIS). As more countries enhance the development of their NIS, the level of global competition for resources, talent and markets will intensify.

Figure 1.1: Relationship Between Innovative Capacity and Wealth in 2014 and 2015



Data source: IMD World Competitive Report for 2014 and 2015.

Malaysia, like all other developing countries, has embarked on an ambitious plan to transform the nation into a knowledge-driven advanced economy, wishing to do so by 2020. In 2000, the Knowledge Economy Master Plan was rolled-out, following which a series of economic plans were launched to enable Malaysian firms to move up the innovation value chain. Empirical analysis shows that while Malaysia's innovative capacity was reasonably high in 2014, knowledge diffusion does not translate into high income for the country (refer to Figure 1.1). The innovative capacity in 2015 was found to decline significantly. The figure also shows the 'knowledge-wealth chasm' remained high for Malaysia in 2015.

To study the 'knowledge-wealth chasm' and effectiveness of the past policy measures, three knowledge content studies were commissioned by the Economic Planning Unit-Prime Minister's Department in 2002, 2007 and 2014/2015, respectively. These studies measured the change in the knowledge content among firms in Malaysia over the period 2002 to 2015. The MYKE III (Phase 1) study examined knowledge content for 21 industries using a sample of 2433 firms. The Knowledge Ecosystem Model developed by Monash University Malaysia and a robust empirical method were used to assess the knowledge ecosystems for the 21 industries. To complement the empirical analysis, the study also interviewed 189 industry players. The detailed qualitative feedback provided a more holistic characterisation and state-of-play of the 21 industries' knowledge ecosystems and the overall Malaysian economy. The study provides valuable insights on the gaps in the Malaysian knowledge ecosystem in the 21 industries. The study also puts forward recommendations to close these gaps in the ecosystems and identifies best practices from countries with high competitive and developed knowledge ecosystems for the industries.

The study is not without limitations. One of the limitations is that for some of the industries, the sub-industries were very diverse; and, measuring an aggregated knowledge ecosystem for the industry may not accurately capture more complex relationships between the knowledge enablers, dynamic capability components and economic outcomes for the industry. Further, the sample used in MYKEIII (Phase 1) was not a representative sample of the industries; hence, the complex relationships captured for the industry may not be representative of the underlying dynamics found in the industry. To overcome these limitations, the MYKE III (Phase 2) was initiated to allow for a more in-depth analysis of 8 industries using a representative sample of the industries. In Phase 2, some of the industries were disaggregated to capture the complex dynamics found in the sub-industries. The empirical results obtained from Phase 2 will provide a more accurate description of the knowledge ecosystems of the industries and the gaps therein. This enables more effective policy formulation to strengthen the ecosystem. Hence, the objectives of the MYKE III (Phase 2) study are as follows:

- assess the knowledge ecosystem and knowledge content of each industry and sub-sectors (where possible at 5-digit level, subject to data availability);
- identify key success factors and gaps in the ecosystem that encourage or hinder knowledge content among firms in these industries;
- identify best practices that have enabled some firms to enhance their knowledge intensity and competitiveness; and,
- identify policies, strategies, action plans, including intervention programmes to promote greater application of knowledge and technology in these industries.

The chapter is structured as follows. In Section 1.1, a brief description of the knowledge ecosystem model used for the MYKE III (Phase 2) is provided. In Section 1.2, the paper explains the sample design for this study. A brief description of the sample used for the MYKE III (Phase 2) is discussed. In Section 1.3, the research methodology for the study is explained. In Section 1.4, the organisation of the chapters in the report are provided.

1.1. The Knowledge Ecosystem Model for MYKE III (Phase 2)

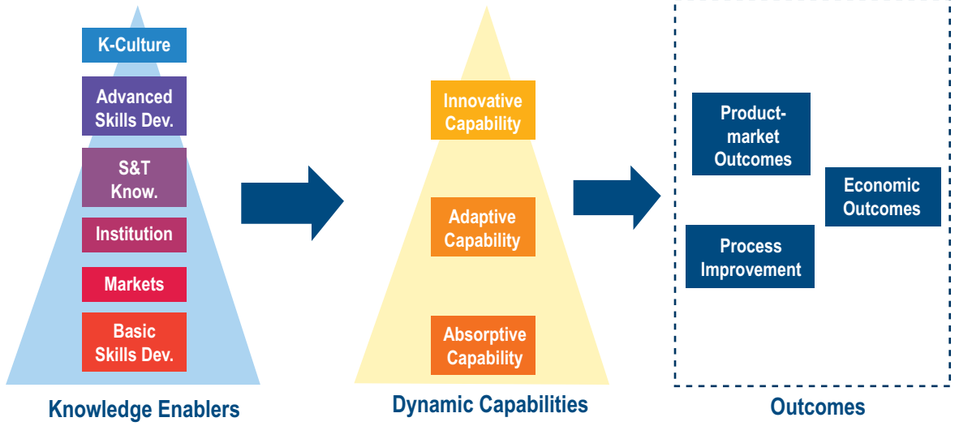
The definition of knowledge content for MYKE III (Phase 2) was adopted from the MYKE I, which is defined as follows:

"the sum of human capabilities, leadership assets and experience, technology and information capital, collaborative relationships, intellectual property, information stocks, and capabilities for shared learning and utilisation that can be used to create wealth and foster economic competitiveness" (EPU, 2009, p.16).

In the MYKE III (Phase 2), the knowledge ecosystem model used is shown in Figure 1.2. The MYKE III knowledge ecosystem model consists of three broad components, which include the following:

- **Knowledge Enablers**
  - Basic Skills Development;
  - Market Intelligence;
  - Institutions – Government, Trade Associations and Universities;
  - Science & Technology Knowledge;
  - Advanced Skills Development; and
  - Knowledge Culture in an organisation.
- **Dynamic Capabilities**
  - Absorptive capability;
  - Adaptive capability; and
  - Innovative capability.
- **Economic Outcomes**
  - Process Improvement; and
  - Product market outcomes.

Figure 1.2: The Working Knowledge Ecosystem Model for MYKE III (Phase 2)



A detailed description of the constructs for the knowledge ecosystem model used for MYKE III (Phase 2) is given in **Table 1.1**

Table 1.1: Descriptions of the Constructs Used in the MYKE III Model

No	Constructs	Descriptions
1	Basic Skills Development	Use of knowledge gained through experience or on-the-job training and learning (non-managerial/basic competency).
2	Market Intelligence	Intelligence gained or provided by: • Suppliers (e.g. equipment, materials, components or software). • Customers. • Clients or users. • Competitors. • External consultants.
3	Institutions	• Universities or other higher education institutes. • Government research organizations. • Other public business assistance or technical or training centres. • Trade associations; local or national business organizations.
4	Science & Technology (S&T) Knowledge	Acquisition of higher order S&T capability via the following channels: • Engagement with conferences, seminars, technical meetings, professional societies. • Access and contribution to journals & technical papers. • Online information sources. • Fairs, exhibitions. • External accreditation and certifications.
5	Advanced Skills Development	Higher-order specialist skills and expertise; such that they allow employees to: • be creative • develop new ideas and knowledge.
6	Knowledge Culture in organisation	• Improving knowledge capabilities is one of our most important business priorities at present. • Our employees are motivated to learn new skills. • We have trade secrets or know-how that we carefully protect. • Our competitiveness is based more on informal (tacit) knowledge, rather than formal (documented, codified) knowledge. • We know who to ask for good advice to improve our knowledge capabilities.
7	Absorptive capability	• Scan the market environment for new customer insights and opportunities. • Acquire technologies from external sources. • Regular meetings/workshops to fully understand, learn and then transfer new knowledge into all parts of the organization. • Systematically store market and technological knowledge for future reference. • Collect and communicate relevant knowledge across the units of our firm.

Table 1.1: Descriptions of the Constructs Used in the MYKE III Model (cont'd)

No	Constructs	Descriptions
8	Adaptive capability	• Financially committed to improve technology and innovation. • Continuously invest to improve our marketing capability. • Have sufficient resources (employees, finances, R & D know-how) to be able to respond quickly to new opportunities. • Develop new structures and processes (e.g., new administrative processes, staff development programmes, rules and procedures) that align with external changes.
9	Innovative capability	• Leverage our existing market knowledge and technological capability in the development of improved new products/services/processes. • Integrate resources and knowledge-base to enter new markets. • Quickly set-up product development teams once we identify a good business opportunity.
10	Process Improvement	• Technologically new or significantly improved processes for producing or supplying products (goods or services). • New or significantly improved internal management or organizational methods. • New or significantly improved marketing concepts/strategies.
11	Product market outcomes	• Introduced products/services that were new to the firm. • Introduced products/services that were completely new to the market.
12	Economic Outcomes	• Change in productivity; • Change in profits; • Change in sales; • Growth in sales • Growth in profitability; • Return on investment; and • Growth in market share

1.2 Sample Design for MYKE III (Phase 2)

Using the framework shown in Figure 1.2, the knowledge ecosystem model for the following industries given in Table 1.2 were estimated using a sample obtained from DOSM.

Table 1.2: List of 21 Industries Selected for MYKE III Based on DOSM Classification

Industries	Industries
1. Agriculture – *Palm oil*	10. Chemicals
2. Agriculture – *Other plant crops*	11. Petroleum
3. Agriculture – *Forestry*	12. Pharmaceuticals
4. Agriculture – *Fishery*	13. Rubber
5. Agriculture – *Livestock*	14. Plastics
6. Electrical & Electronics – *Components*	15. Wholesale
7. Electrical & Electronics – *Final Products*	16. Retail
8. Food processing	17. Business Services – *Business Development*
9. Machinery & Instrumentation	18. Business Services – *Technical Services*

A questionnaire was designed for the knowledge ecosystem model for MYKE III (Phase 2) shown in Figure 1.2 and is given in Appendix 1. The data used for this study is based on the industries sector using random sampling method administered by the DOSM. A total of 4,438 sample respondents were obtained from DOSM. A summary of the representative sample is shown in Table 1.3 based on the 8 industries; Table 1.4 depicts the sample based on states across Malaysia; and, Table 1.5 based on regions.

Table 1.3: Sample Based on Industries

Industries	Large	Micro-SME	TOTAL	Foreign	Local
Agriculture	355	475	**830**	23	807
Food processing	45	162	**207**	23	184
Chemical, Petroleum & Pharmaceuticals	81	148	**229**	85	144
Rubber & Plastics	120	246	**366**	89	277
Electrical & Electronics	236	248	**484**	256	228
Machinery & Instruments	38	64	**102**	37	65
Business Services	65	337	**402**	45	357
Wholesale/Retail	378	1440	**1818**	149	1669
Total	**1318**	**3120**	**4438**	**707**	**3731**

Table 1.4: Sample Based on States

States	Large	Micro-SME	TOTAL	Foreign	Local
Johor	179	398	**577**	141	436
Kedah	67	139	**206**	40	166
Kelantan	12	125	**137**	2	135
Kuala Lumpur	173	385	**558**	77	481
Labuan	1	14	15	**0**	15
Melaka	44	94	**138**	30	108
Negeri Sembilan	43	92	**135**	30	105
Pahang	37	177	**214**	21	193
Perak	66	230	**296**	30	266
Perlis	0	2	**2**	0	2
Pulau Pinang	106	206	**312**	87	225
Sabah	162	368	**530**	21	509
Sarawak	75	279	**354**	21	333
Selangor	337	521	**858**	200	658
Terengganu	16	90	**106**	7	99
Malaysia	**1318**	**3120**	**4438**	**707**	**3731**

Table 1.5: Sample Based on Regions

Regions	Large	Micro-SME	TOTAL	Foreign	Local
NCER	177	368	**545**	127	418
ECER	84	424	**508**	40	468
GKL	470	854	**1324**	261	1063
Iskandar	134	255	**389**	123	266
SCORE	32	116	**148**	8	140
SDC	162	368	**530**	21	509
Others	259	735	**994**	127	867
Total	**1318**	**3120**	**4438**	**707**	**3731**

1.3 Research Methodology for MYKE III (Phase 2)

In MYKE III (Phase 2), both qualitative and quantitative methods were used to capture the state of development of the knowledge ecosystem of the industry. In the context of the qualitative method, in-depth focus group interviews were undertaken with industry associations, government agencies and industry captains. In the case of the quantitative analysis, Structural Equations Model (SEM) was used to capture the complex dynamics between k-enabler, dynamic capabilities components and economic outcomes. Technical details on SEM are given in Appendix 2.

1.4 Organisation of the Report

The organisation of the report is outlined in the following way. From Chapters 2 to 20, a detailed analysis of knowledge content for each of the 19 sub-industries is discussed. The chapters cover the following: a brief overview of the industry; an exposition of the knowledge ecosystem of the industry in advanced countries; and a description of the knowledge ecosystem of the industry in Malaysia, which includes identifying the strengths and gaps in the knowledge ecosystem; recommendations to improve the knowledge ecosystem of the industry, including a number of best practices. The final chapter identifies common issues that impact the 8 industries and the respective sub-industries, proposing recommendations to overcome some of the challenges encountered by the industries due to their structural weaknesses.

References

1. Arrow, K.J. (1962). Economic welfare and allocation of resources of invention. In R.R. Nelson (Eds.), The rate and direction of inventive activity: economic and social factors (pp. 609-625). Princeton University Press for the National Bureau of Economic Research.

2. Lucas, R.B. (1998). On the mechanics of economic development. *Journal of Monetay Economics*, 22, June, 2-32.

3. Romer, P. (1990). Endogenous Technological Change. *Journal of Political Economy,* 8(5), 71-102.

DEPARTMENT OF STATISTICS, MALAYSIA
www.statistics.gov.my

Confidential when filled with data

Please make a copy for your record

MALAYSIAN KNOWLEDGE CONTENT SURVEY 2015 (FOR REFERENCE YEAR 2014)

Name of estant and postal address

Please amend if there are any changes in the above postal address

For enquiries, please contact:

Tel. No.: _____

Fax. No.: _____

Email: _____

OFFICE USE

Serial Number

DECLARATION

Name:

Designation:

Telephone:

Fax. No.:

Email:

I hereby declare that the information given in this return is complete and correct to the best of my knowledge and belief.

singature:

Date:

GENERAL INFORMATION

a. The Department of Statistics, Malaysia is conducting the Malaysian Knowledge Content Survey 2015 (for reference year 2014).

b. The main objective is to provide assessment of knowledge content and practices in key economic sectors to formulate policies, strategies and action plans in promoting greater application of knowledge and technology.

c. The information is gathered under the provisions of the Statistics Act 1965 (Revised - 1989). Section 5 of this Act requires all establishments operating in Malaysia to provide actual information or best estimates to the Department. The Act stipulates that the contents of the individual returns are CONFIDENTIAL and will not be divulged to any person or institution outside this Department. Meanwhile, Section 7 under the same Act provides the penalty to the respondent that could not comply with the survey undertaken.

d. You are requested to provide information related to your establishment as stated above and return the completed questionnaire to the Department.

DATUK DR. HJ. ABDUL RAHMAN HASAN
CHIEF STATISTICIAN, MALAYSIA

Date:

Your co-operation in ensuring the success of this survey is very much appreciated

Malaysian Knowledge Content Survey 2015

Industry Sector and Establishment Profile

1.0. In terms of size, this establishment is best described as a (Please tick only ONE)

a.	☐	**Microenterprise**: Sales turnover of **less than RM300,000** OR less than **5 full-time employees**
b.	☐	**Small** company (*Manufacturing sector*): Sales turnover from **RM300,000 to less than RM15 millio**n OR **full-time employees from 5 to less than 75**
c.	☐	**Small company** (*Services & Other Sectors*): Sales turnover from **RM300,000 to less than RM3 million** OR **full-time employees from 5 to less than 30**
d.	☐	**Medium** company (*Manufacturing sector*): Sales turnover from **RM15 million to not exceeding RM50 million** OR **full-time employees from 75 to not exceeding 200**
e.	☐	**Medium** company (*Services & Other Sectors*): Sales turnover from **RM3 million to not exceeding RM20 million** OR **full-time employees from 30 to not exceeding 75**
f.	☐	**Large** company (*Manufacturing sector*): Sales turnover above **RM50 million** OR **full-time employees above 200**
g.	☐	**Large** company (*Services & Other Sectors*): Sales turnover **above RM20 million** OR **full-time employees above 75**

1.1. In what **year** did your firm start its business operation(s)?

2.0. Is your **parent group/holding** company located in Malaysia?

a. ☐ Yes, it is located in | | | | | (postcode ONLY)
b. ☐ No, it is located in _____ (country outside Malaysia)
c. ☐ Not Applicable

2.1. In terms of **ownership structure**, is your establishment a (Please tick only ONE)

a. ☐ Wholly owned Malaysian company
b. ☐ Wholly owned foreign subsidiary
c. ☐ Partnership involving only Malaysian entities
d. ☐ Majority Malaysian owned
e. ☐ Partnership with foreign entities (e.g., joint venture, strategic alliances etc.)
Please specify country of origin of foreign partner(s):
_____

2.2. Please specify if your establishment is a "Co-Operative".

a. ☐ Yes
b. ☐ No

3.0. Does your establishment engage in or use the following in its activities?

a. ☐ Biotechnology
b. ☐ Nanotechnology
c. ☐ Not used

4.0. In your assessment, is your main industry/sector growing or declining in revenue over the four year period 2011-2014? Please indicate the average annual rate of growth or decline in your main industry/ sector. Please tick only ONE.

a. ☐	b. ☐	c. ☐	d. ☐	e. ☐
Rapid decline	Steady decline	Not growing or declining	Steady growth	Rapid growth
(< -15%)	(-15% to -3%)	(-2% to +2%)	(3% to 15%)	(>15%)

5.0. Please indicate the **core business area(s)** of operation that your establishment is involved in over the period 2011-2014.

(Please tick ALL that apply)

a. ☐ Production and Manufacturing
b. ☐ Research and Development (R&D)
c. ☐ Commercialisation of R&D
d. n Sales and Marketing
e. ☐ Wholesale and Retail
f. ☐ Exports
g. ☐ Imports
h. ☐ Franchise operations
i. ☐ Services
j. Others (please specify): _____

6.0. Please indicate your **market presence** by proportion of revenue for this establishment in 2014.

	Percentage (%) of revenue
a. Within the state	
b. National (excluding the amount indicated in (a) above)	
c. ASEAN + 3 (China, Japan, & South Korea)	
d. International (excluding the amount indicated in (c) above)	
Total:	100 %

Knowledge Base, Innovation and Knowledge Sources

7.0. We seek your assessment in relation to your **awareness of knowledge and innovation** in the industry. Please indicate your level of agreement or disagreement. *(**Select** on the scale 1 to 5, where 1=strongly disagree; 2=disagree; 3=neither agree nor disagree; 4=agree; 5=strongly agree)*

Industry awareness	**Strongly disagree**				**Strongly agree**
a. We are well informed about competitor's strengths and weaknesses	1	2	3	4	5
b. We are well aware of information about the technological developments affecting our sector	1	2	3	4	5
c. We collect information about final and intermediate customers (middle-men, agents etc.)	1	2	3	4	5
d. We are well acquainted with the standards and regulations associated with our sector	1	2	3	4	5

7.1. We seek your assessment in relation to **organisational processes and activities** at your establishment. Please indicate your level of agreement or disagreement. *(**Select** on the scale 1 to 5, where 1=strongly disagree; 2=disagree; 3=neither agree nor disagree; 4=agree; 5=strongly agree)*

Process awareness	**Strongly disagree**				**Strongly agree**
a. Our employees are highly knowledgeable about how the various processes and activities are performed	1	2	3	4	5
b. Our employees are highly experienced in relation to how processes and activities are performed	1	2	3	4	5
c. Our employees are very familiar with the processes and activities they carry out	1	2	3	4	5
d. We have well established routines and procedures for performing processes and activities	1	2	3	4	5

8.0. Provided below are a range of **approaches to managing knowledge**.
Please indicate your level of agreement or disagreement with the statements below. *(**Select** on the scale 1 to 5, where 1=strongly disagree; 2=disagree; 3=neither agree nor disagree; 4=agree; 5=strongly agree)*

Awareness of knowledge	**Strongly disagree**				**Strongly agree**
a. We frequently scan the market environment for new customer insights and opportunities	1	2	3	4	5
b. We frequently acquire technologies from external sources	1	2	3	4	5
c. We regularly have meetings/workshops to fully understand, learn and then transfer new knowledge into all parts of the organisation	1	2	3	4	5
d. We systematically store market and technological knowledge for future reference	1	2	3	4	5
e. We regularly collect and communicate relevant knowledge across the units of our firm	1	2	3	4	5
Organisational integration and use of knowledge					
f. We are financially committed to improve technology and innovation	1	2	3	4	5
g. We continually invest to improve our marketing capability	1	2	3	4	5
h. We have sufficient resources (employees, finances, R & D know-how) to be able to respond quickly to new opportunities	1	2	3	4	5
i. We are able to develop new structures and processes (e.g., new administrative processes, staff development programmes, rules and procedures) that align with external changes	1	2	3	4	5
j. We spend considerable time and effort in trying to understand how to use new knowledge (technological and market) within the organisation in order to capitalise on new business opportunities	1	2	3	4	5
Transformative use of knowledge					
k. We are able to leverage our existing market knowledge and technological capability in the development of improved new products/services/ processes	1	2	3	4	5
l. We are able to integrate our resources and knowledge-base to enter new markets	1	2	3	4	5
m. We are highly proficient in transforming technological knowledge into new products/services/processes	1	2	3	4	5
n. Our employees frequently share their expertise to develop new products/services/processes	1	2	3	4	5
o. We quickly analyse and interpret changing market demands for our technologies	1	2	3	4	5
p. We can successfully reconfigure our resources to come up with new productive assets	1	2	3	4	5
q. We are able to quickly set-up product development teams once we identify a good business opportunity	1	2	3	4	5

9.0. We seek your assessment on the **acquisition and use of knowledge** at your establishment. Please indicate your level of agreement or disagreement. *(**Select** on the scale 1 to 5, where 1=strongly disagree; 2=disagree; 3=neither agree nor disagree; 4=agree; 5=strongly agree) [Note: Knowledge capabilities refer to the skills and competencies needed to engage in high value-added activities.]*

Knowledge capabilities	**Strongly disagree**				**Strongly agree**
a. Improving knowledge capabilities is one of our most important business priorities at present	1	2	3	4	5
b. We are not sure how improved knowledge capabilities would lead to better business results	1	2	3	4	5
c. Customers do not demand new or improved products, processes or services	1	2	3	4	5
d. Our employees are motivated to learn new skills	1	2	3	4	5
e. We have trade secrets or know-how that we carefully protect	1	2	3	4	5
f. Our competitiveness is based more on informal (tacit) knowledge, rather than formal (documented, codified) knowledge	1	2	3	4	5
g. We know who to ask for good advice to improve our knowledge capabilities	1	2	3	4	5
h. We lack time to develop plans to improve knowledge capabilities	1	2	3	4	5
i. We lack money to implement plans to improve knowledge capabilities	1	2	3	4	5

9.1. From the statements below, please indicate the one that most closely describes your organisation.
*(**Select** on the scale 1 to 5, where 1=strongly disagree; 2=disagree; 3=neither agree nor disagree; 4=agree; 5=strongly agree)*

In our organisation…	**Strongly disagree**				**Strongly agree**
a. people are willing to share information or knowledge with each other	1	2	3	4	5
b. failures or mistakes are regarded as opportunities to learn	1	2	3	4	5
c. encouragement and incentives are provided to share information and knowledge	1	2	3	4	5
d. people who create new knowledge are recognised and rewarded	1	2	3	4	5
e. the primary means of sharing information and knowledge is through information technology (IT) based systems	1	2	3	4	5
f. we systematically collect and store information and knowledge in IT based systems	1	2	3	4	5
g. the main way we share information and knowledge is through **informal** meetings	1	2	3	4	5
h. the main way we share information and knowledge is through **formal** meetings	1	2	3	4	5

10.0. Please indicate the **sources of knowledge or information** used over the four year period 2011 – 2014 to make improvements or changes in products and processes. *Please indicate the importance of the knowledge source on a scale 1 to 5, where 1=very low importance; 2=low importance; 3=moderate importance; 4=high importance; 5=very high importance.*

Knowledge Sources	Not used	Used	Very low importance				Very high importance
Internal							
a. Other units in the establishment group - subsidiaries, affiliates or associated business units within the parent or holding company	☐	☐➔	1	2	3	4	5
Market							
b. Suppliers (e.g. equipment, materials, components or software)	☐	☐➔	1	2	3	4	5
c. Customers, clients or users	☐	☐➔	1	2	3	4	5
d. Competitors	☐	☐➔	1	2	3	4	5
e. External consultants	☐	☐➔	1	2	3	4	5
f. Commercial R & D laboratories	☐	☐➔	1	2	3	4	5
Institutional							
g. Universities or other higher education institutes	☐	☐➔	1	2	3	4	5
h. Government and public research organisations	☐	☐➔	1	2	3	4	5
j. Trade associations; local or national business organisations	☐	☐➔	1	2	3	4	5
Others							
k. Conferences, seminars, technical meetings, professional societies	☐	☐➔	1	2	3	4	5
l. Printed journals, technical papers	☐	☐➔	1	2	3	4	5
m. Online information sources	☐	☐➔	1	2	3	4	5
n. Fairs, exhibitions	☐	☐➔	1	2	3	4	5
o. Merger with or acquisition of another company	☐	☐➔	1	2	3	4	5
p. Recognition based on external accreditation and certifications	☐	☐➔	1	2	3	4	5

Strategy and Planning

11.0. Rate the importance of the following **strategies** to your establishment. *(**Select** on the scale 1 to 5, where N/A=Not applicable; 1=very low importance; 2=low importance; 3=moderate importance; 4=high importance; 5=very high importance)*

Strategies	N/A	Very low importance				Very high importance
a. Reduce the cost of doing business in existing operations	☐	1	2	3	4	5
b. Develop practices to enhance quality	☐	1	2	3	4	5
c. Increase firm size through acquisition, merger or joint venture	☐	1	2	3	4	5
d. Increase exports or expand into foreign markets	☐	1	2	3	4	5
e. Encourage staff education/upgrading skills	☐	1	2	3	4	5
f. Acquire knowledge from external sources, including customers, other industry sources and universities	☐	1	2	3	4	5
g. Apply own in-house research and development	☐	1	2	3	4	5
h. Develop firm policies and practices for knowledge/intellectual property protection	☐	1	2	3	4	5

11.1. Please indicate the degree to which each of the following **competitive dimension**s is emphasised in your establishment. *(**Select** on the scale 1 to 5, where N/A=Not applicable; 1=very little emphasis; 2=little emphasis; 3=moderate emphasis; 4=strong emphasis; 5=very strong emphasis)*

Competitive dimensions	N/A	Very little emphasis				Very strong emphasis
a. Targeting high priced segment(s)	☐	1	2	3	4	5
b. Advertising	☐	1	2	3	4	5
c. Building/maintaining the firm's reputation	☐	1	2	3	4	5
d. Premium product/service quality	☐	1	2	3	4	5
e. Managing cost (E.g. raw material, technology, personnel etc.)	☐	1	2	3	4	5
f. Production or service process improvements and innovation	☐	1	2	3	4	5
g. Product or service cost reduction	☐	1	2	3	4	5
h. Serving special market segment(s)	☐	1	2	3	4	5
i. Manufacturing/selling customised products or services	☐	1	2	3	4	5

11.2. Please comment on your **strategy for exports and international markets.** *(**Select** on the scale 1 to 5, where N/A=Not applicable; 1=strongly disagree; 2=disagree; 3=neither agree nor disagree; 4=agree; 5=strongly agree)*

Our company / company's…	N/A	Strongly disagree				Strongly agree
a. actively explores new business opportunities abroad	☐	1	2	3	4	5
b. continuously communicates the mission to succeed in international markets to firm employees	☐	1	2	3	4	5
c. developed human and other resources for achieving its goals in international markets	☐	1	2	3	4	5
d. top managers communicated information throughout the firm with respect to our successful and unsuccessful customer experiences abroad	☐	1	2	3	4	5
e. top managers were willing to go to great lengths to make our products or services succeed in foreign markets	☐	1	2	3	4	5
f. vision and drive of top managers were very important in our decision to enter foreign markets	☐	1	2	3	4	5

11.3. Please indicate the achievement of **overall strategy** *(**Select** on the scale 1 to 5, where 1=not achieved; 2=somewhat achieved; 3=moderately achieved; 4=achieved; 5=achieved beyond expectation)*

Overall strategy…	Not achieved				Achieved beyond expectation
Considering the strategies and competitive dimensions, to what extent has the overall intended competitive strategy for this business been achieved?	1	2	3	4	5

12.0. Please indicate if the following **constraints** hindered your move to **international market**(s): *(**Select** on the scale 1 to 5 on the level of constraint, where N/A=Not applicable; 1=very low; 2=low; 3=moderate; 4=high; 5=very high)*

Constraints to international market expansion	Level of Constraint						
	N/A	Very low				Very high	
a. Financial	☐	1	2	3	4	5	
b. Human Capital	☐	1	2	3	4	5	
c. Network (business connections and contacts)	☐	1	2	3	4	5	
d. Information and Knowledge	☐	1	2	3	4	5	
e. Language barrier	☐	1	2	3	4	5	
f. Regulations and Policies	☐	1	2	3	4	5	
g. Culture and Tradition	☐	1	2	3	4	5	

12.1. Please indicate if the following **constraints** hindered your move in **domestic market**(s): *(**Select** on the scale 1 to 5 on the level of constraint, where N/A=Not applicable; 1=very low; 2=low; 3=moderate; 4=high; 5=very high)*

Constraints to domestic market expansion	Level of Constraint						
	N/A	Very low				Very high	
a. Financial	☐	1	2	3	4	5	
b. Human Capital	☐	1	2	3	4	5	
c. Network (business connections and contacts)	☐	1	2	3	4	5	
d. Information and Knowledge	☐	1	2	3	4	5	
e. Language barrier	☐	1	2	3	4	5	
f. Regulations and Policies	☐	1	2	3	4	5	
g. Culture and Tradition	☐	1	2	3	4	5	

Human Resources

13.0. Please indicate the **number of your full-time and part-time employees** in the following categories in 2014.

Categories of employees	Full Time (Number)	Part Time (Number)
a. Managerial and professional		
b. Supervisory		
c. Technical		
d. Administrative support		
e. General workers		

13.1. Please indicate the l**evel of industry experience** of your workforce. *(**Select** on the scale 1 to 5, where N/A=Not applicable; 1=very low experience (<1 year); 2=low experience (1-3 years); 3=moderate experience (4-5 years); 4=high experience (6-10 years); 5=very high experience (>10 years))*

Categories of employees	N/A	Very low				Very high
a. Managerial and professional	☐	1	2	3	4	5
b. Supervisory	☐	1	2	3	4	5
c. Technical	☐	1	2	3	4	5
d. Administrative support	☐	1	2	3	4	5
e. General workers	☐	1	2	3	4	5

13.2. What is the **average rate of worker turnover** in 2014? *(**Select** on the scale 1 to 5, where N/A=Not applicable; 1=very low turnover (<5%); 2=low turnover (5%-10%); 3=moderate turnover (11%-20%); 4=high turnover (21%-30%); 5=very high turnover (>30%))*

Categories of employees	N/A	Very low				Very high
a. Managerial and professional	☐	1	2	3	4	5
b. Supervisory	☐	1	2	3	4	5
c. Technical	☐	1	2	3	4	5
d. Administrative support	☐	1	2	3	4	5
e. General workers	☐	1	2	3	4	5

13.3. We seek your **assessment of your employees**. Please indicate your level of agreement or disagreement. *(**Select** on the scale 1 to 5, where 1=strongly disagree; 2=disagree; 3=neither agree nor disagree; 4=agree; 5=strongly agree)*

Human Capital	Strongly disagree				Strongly agree
a. Our employees are highly skilled	1	2	3	4	5
b. Our employees are widely considered the best in our industry	1	2	3	4	5
c. Our employees are creative and bright	1	2	3	4	5
d. Our employees are experts in their particular jobs and functions	1	2	3	4	5
e. Our employees develop new ideas and knowledge	1	2	3	4	5

13.4. To what extent do **non-managerial workers** use competencies gained through experience or on-the-job training and learning to perform their jobs? *(**Select** on the scale 1 to 5 on the level of use, where N/A=Not applicable; 1=very low; 2=low; 3=moderate; 4=high; 5=very high)*

Non-managerial workers	N/A	Very low				Very high
Use of knowledge gained through experience or on-the-job training and learning	☐	1	2	3	4	5

13.5. What are the **factors** that **constrain skills and knowledge development** of workers at your establishment?
*(**Select** on the scale 1 to 5 on the level of constraint, where N/A=Not applicable; 1=strongly disagree; 2=disagree; 3=neither agree nor disagree; 4=agree; 5=strongly agree)*

Factors	N/A	Strongly disagree				Strongly agree
a. Limited training budget	☐	1	2	3	4	5
b. Uncertainty about what new knowledge will be important in the future	☐	1	2	3	4	5
c. Uncertainty about future business growth	☐	1	2	3	4	5
d. Lack of relevant training programs	☐	1	2	3	4	5
e. Lack of proficiency in English of existing workforce	☐	1	2	3	4	5
f. Unwillingness of workers to acquire new knowledge	☐	1	2	3	4	5
g. High turnover of skilled workers after training	☐	1	2	3	4	5

13.6. Please indicate your **level of agreement or disagreement** on the following career development pathways at your establishment.
*(**Select** on the scale 1 to 5, where 1=strongly disagree; 2=disagree; 3=neither agree nor disagree; 4=agree; 5=strongly agree)*

Our company…	Strongly disagree				Strongly agree
a. has a clear career development path for all our employees	1	2	3	4	5
b. has leadership development initiatives or plans to ensure career progression	1	2	3	4	5

13.7. Please indicate the **level of adequacy of human resources** in your establishment. Note: Adequacy is defined by the level of constraint or shortages in human resources. *(**Select** on the scale 1 to 5 on the level of constraint, where N/A=Not applicable; 1=no constraint; 2=low constraint; 3=moderate constraint; 4=high constraint; 5=very high constraint)*

Adequacy of human resources	N/A	No constraint				Very high constraint
a. Senior management (e.g CEO, COO, CFO, Directors, Deputy Directors, General Manager etc.)	☐	1	2	3	4	5
b. Middle management (e.g Marketing Managers, Operations Managers, Sales Managers etc.)	☐	1	2	3	4	5
c. Supervisory (staff overseeing performance of other employees)	☐	1	2	3	4	5
d. Technical (e.g Engineers, laboratory technicians, scientific officer etc.)	☐	1	2	3	4	5
e. Administrative support	☐	1	2	3	4	5
f. General workers	☐	1	2	3	4	5

14.0. Please indicate the **number of full time (FT) employees (including contract staff)** who possess the following qualifications?
(Please indicate the highest qualification only)

Field of specialisation	No	Yes	Skills/ Vocational Certificate (Number)	Diploma (Number)	Under-graduate degree (Number)	Masters degree (Number)	PhD (Number)	Professional Certificate (Number)
a. Computer science and software development	☐	☐➔						
b. Electrical and electronic engineering (including computer hardware)	☐	☐➔						
c. Biotechnology (including biochemistry, bioinformatics, molecular biology, micro biology, biomedical engineering)	☐	☐➔						
d. Other natural science (including physics, other chemistry, other biology)	☐	☐➔						
e. Other engineering & technology (not electrical, electronic, computer hardware)	☐	☐➔						
f. Medical sciences (basic medicine, clinical medicine, health science, biostatistics)	☐	☐➔						
g. Agricultural sciences (forestry, fishery, horticulture, veterinary)	☐	☐➔						
h. Business administration, management, accounting, economics	☐	☐➔						
i. Social sciences, humanities, law, and all other fields	☐	☐➔						
j. Others (please specify): _____	☐	☐➔						

Entrepreneurial Approach and Practice

15.0. Looking at your organisation as a whole, please indicate your entrepreneurial approach.
*(**Select** on the scale 1 to 5 to indicate the level of frequency, where 1=never; 2=seldom; 3=sometimes; 4=often; 5=always)*

In our business, we…	**Never**				**Always**
a. place a strong emphasis on developing own technology and innovation instead of using other firms' innovations	1	2	3	4	5
b. prefer to grow existing lines of products or services rather than developing new ones	1	2	3	4	5
c. prefer making major changes to our existing products or services	1	2	3	4	5
d. respond to actions that competitors initiate	1	2	3	4	5
e. are the first to introduce new products or services, administrative techniques, operating technologies, etc.	1	2	3	4	5
f. compete aggressively	1	2	3	4	5
g. have a strong tendency for low-risk projects (with normal and certain rates of return)	1	2	3	4	5
h. take small and gradual steps to achieve our business objectives	1	2	3	4	5
i. are quick to seize opportunities even when we are unsure about success	1	2	3	4	5

Market Approach

Please look at the descriptions below and select the one that BEST describes your organisation.

16.0. In contrast to our competitors, my organisation has an i**mage in the marketplace** as one which:
*(Please **select one** from the four options below)*

a. ☐	Offers fewer, selective products and services that are high in quality.
b. ☐	Adopts new ideas and innovation, but only after careful analysis.
c. ☐	Reacts to opportunities or threats in the marketplace to maintain or enhance our position.
d. ☐	Has a reputation for being innovative and creative.

16.1. In comparison to our competitors, the **increase or decrease in our market share** is most probably due to:
*(Please **select one** from the four options below)*

a. ☐	Our practice of concentrating on more fully developing those markets that we currently serve.
b. ☐	Our practice of responding to the immediate needs of the marketplace.
c. ☐	Our practice of aggressively entering into new markets with new types of products and service offerings.
d. ☐	Our practice of assertively penetrating more deeply into new markets, while offering new products and services only after a very careful review of their potential.

16.2. In contrast to our competitors, the **skills** that our managerial employees possess can be best characterised as:
*(Please **select one** from the four options below)*

a. ☐	Their skills enable them to both identify trends and then develop new product or service offerings or markets.
b. ☐	Their skills are concentrated into one, or a few, specific areas.
c. ☐	Their skills are diverse, flexible, and enable change to be created.
d. ☐	Their skills are related to the near-term demands of the marketplace.

16.3. The one thing that **protects my organisation from competitive failure** is that we:
*(Please **select one** from the four options below)*

a. ☐	Carefully analyse emerging trends and adopt only those that have proven potential.
b. ☐	Do a limited number of things exceptionally well.
c. ☐	Respond to trends as they arise even though they may possess only moderate potential.
d. ☐	Consistently develop new and improved product and service and new markets.

16.4. In comparison to many of our competitors, our **management staff tends to concentrate on**:
*(Please **select one** from the four options below)*

a. ☐	Maintaining a secure financial position through cost and quality control measures.
b. ☐	Analysing opportunities in the market place and selecting only those opportunities with proven potential, while protecting a secure financial position.
c. ☐	Activities or business functions which most need attention given the opportunities or problems we currently confront.
d. ☐	Developing new products and services and expanding into new markets or market segments.

Organisational Culture

From the statements below, please indicate the one that most closely describes your organisation.
*(**Select** on the scale 1 to 5, where 1=strongly disagree; 2=disagree; 3=neither agree nor disagree; 4=agree; 5=strongly agree)*

17.0. My organisation is a very…		**Strongly disagree**				**Strongly agree**
a.	personal place. It is like an extended family. People seem to share a lot of themselves	1	2	3	4	5
b.	dynamic and entrepreneurial place. People are willing to stick their necks out and take risks	1	2	3	4	5
c.	formalised and structured place. Established procedures generally govern what people do	1	2	3	4	5
d.	production oriented. A major concern is with getting the job done, without much personal involvement	1	2	3	4	5

17.1. Supervisors/senior managers in the organisation often take the role of…		**Strongly disagree**				**Strongly agree**
a.	a mentor - a father or mother figure	1	2	3	4	5
b.	an entrepreneur - an innovator, or a risk taker	1	2	3	4	5
c.	a coordinator - an organiser, or an administrator	1	2	3	4	5
d.	a producer - an efficient and outcome driven person	1	2	3	4	5

17.2. My organisation is held together by…		**Strongly disagree**				**Strongly agree**
a.	loyalty and tradition - commitment to this firm runs high	1	2	3	4	5
b.	a commitment to innovation and development - an emphasis on being first	1	2	3	4	5
c.	formal rules and policies - maintaining a smooth running institution is important here	1	2	3	4	5
d.	a production orientation - an emphasis on tasks and goal accomplishment	1	2	3	4	5

17.3. My organisation emphasises…		**Strongly disagree**				**Strongly agree**
a.	human resources - high cohesion and morale in the firm are important	1	2	3	4	5
b.	growth and acquiring new resources - readiness to meet new challenges is important	1	2	3	4	5
c.	permanence and stability - efficient, smooth operations are important	1	2	3	4	5
d.	competitive actions and achievement - measurable goals are important	1	2	3	4	5

18.0. Provided below are a set of statements about the **<u>leadership</u>** of your organisation. Please indicate your level of agreement or disagreement. *(**Select** on the scale 1 to 5, where 1=strongly disagree; 2=disagree; 3=neither agree nor disagree; 4=agree; 5=strongly agree)*

The managers of our organisation…	**Strongly disagree**				**Strongly agree**
a. have a clear understanding of where we are going	1	2	3	4	5
b. say things that make employees proud to be a part of this organisation	1	2	3	4	5
c. say positive things about the work unit	1	2	3	4	5
d. encourage people to use changing environment as situations full of opportunities	1	2	3	4	5
e. challenge employees to think about old problems in new ways	1	2	3	4	5
f. have ideas that force employees to rethink some things that they have never questioned before	1	2	3	4	5
g. behave in a manner which is thoughtful of employees' personal needs	1	2	3	4	5
h. acknowledge employees for improvement in the quality of work	1	2	3	4	5
i. personally compliment employees when they do outstanding work	1	2	3	4	5

Organisational Performance and Outcomes

19.0. During the four year period 2011-2014, did your establishment introduce any **technologically new or significantly improved products or services**? *(**Select** on the scale 1 to 5 of frequency of launching new product or service, where N/A=Not applicable;*
1=very low frequency (0-1 over the 4-year period); 2=low frequency (2 over the 4-year period); 3=moderate frequency (3 over the 4-year period); 4=high frequency (4 over the 4-year period); 5=very high frequency (5 or more over the 4-year period))

Product/service innovation	N/A	Very low				Very high
a. Introduced products or services that were completely new to the market	☐	1	2	3	4	5
b. Introduced products or services that were new to the firm	☐	1	2	3	4	5
c. Introduced new innovation based on competitors' products	☐	1	2	3	4	5

19.1. During the four year period 2011-2014, did your establishment introduce any of the following **improvements or changes**?
*(**Select** on the scale 1 to 5 of level of change, where N/A=Not applicable; 1=no change; 2=incremental change; 3=moderate change; 4=significant change; 5=radical change)*

Process and managerial innovation	N/A	No change				Radical change
a. Technologically new or significantly improved processes for producing or supplying products or services	☐	1	2	3	4	5
b. New or significantly improved internal management or organisational methods	☐	1	2	3	4	5
c. New or significantly improved marketing concepts/strategies	☐	1	2	3	4	5
d. Major changes in business strategy or long-term business goals	☐	1	2	3	4	5

19.2. Please indicate your assessment of the average annual **contribution** of your firm's i**nnovation to sales over the 4 year period (2011-2014).** *(**Select** on the scale1 to 5, where N/A=Not applicable; 1=very low contribution (<5%); 2=low contribution (5%-10%); 3=moderate contribution (11%-15%); 4=high contribution (16%-20%); 5=very high contribution (>20%))*

Overall contribution	N/A	Very low				Very high
Contribution of firm's innovation to sales	☐	1	2	3	4	5

20.0. Referring to current performance of your establishment, please indicate your **performance** level on the following dimensions.
(***Select** on the scale 1 to 5, where N/A=Not applicable; 1=significant decrease (<-25%); 2=decrease (-25% to -6%); 3=no significant change (-5% to +5%); 4=increase (6% to 25%); 5=significant increase (>25%))*

Performance level	N/A	Significant decrease				Significant increase
a. Development and launch of **new products and services** in *Malaysia*	☐	1	2	3	4	5
b. Development and launch of **new products and services** in *ASEAN market*	☐	1	2	3	4	5
c. Development and launch of **new products and services** in *international (other than ASEAN) market*	☐	1	2	3	4	5
d. Development of **new markets** in *Malaysia*	☐	1	2	3	4	5
e. Development of **new markets** in *ASEAN*	☐	1	2	3	4	5
f. Development of **new markets** *internationally (other than ASEAN)*	☐	1	2	3	4	5

20.1. Referring to the past four years 2011-2014, please indicate the average annual percentage change for the following performance indicators of your establishment. *(**Select** on the scale 1 to 5 average annual of change, where 1=significant decrease (<-20%); 2=decrease (-20% to -6%); 3=no significant change (-5% to +5%); 4=increase (6% to 20%); 5=significant increase (>20%))*

Performance indicators	Significant decrease				Significant increase
a. Change in productivity	1	2	3	4	5
b. Change in profits	1	2	3	4	5
c. Change in sales	1	2	3	4	5

20.2. Referring to the past four years 2011-2014, please comment on the following performance indicators of your establishment **relative to competitors**. (***Select** on the scale 1 to 5, where 1=much worse than competitors (< -20%); 2=worse than competitors (-20% to -6%); 3=about the same as competitors (-5% to +5%); 4= better than competitors (6% to 20%); 5=much better than competitors (>20%))*

Performance level	Much worse than competitors				Much than better competitors
a. Growth in sales	1	2	3	4	5
b. Growth in profitability	1	2	3	4	5
c. Return on investment	1	2	3	4	5
d. Growth in market share	1	2	3	4	5

20.3. To what extent did your establishment achieve the following outcomes over the past 4 years (2011-2014). Please indicate the average annual percentage across the 4 years (2011-2014). (Select on the scale 0 to 5, where 0=none; 1=very low (0%-10%); 2=low (11%-20%); 3=moderate (21%-30%); 4=high (31%-40%); 5=very high (above 40%)) [Note: Knowledge intensive activities are those that require advanced/specialist knowledge that create high value added to product or service or society]

Outcomes	None	Very low				Very high
a. Percentage of increase in knowledge intensive jobs	0	1	2	3	4	5
b. Number of employed persons in knowledge intensive activities as a % of total employed	0	1	2	3	4	5
c. Knowledge intensive exports (product or service) as a % of total sales	0	1	2	3	4	5
d. Sales of new to market and new to firm innovation as % of total sales	0	1	2	3	4	5
e. Sales generated from license and patents owned by the establishment as % of total sales	0	1	2	3	4	5

20.4. Please provide the following information. If exact figures are not available, please give your best estimate. Answers can be rounded.

	2014	
a. What was the total revenue of this establishment in 2014?		RM
b. What percentage of the establishment's total revenue was from exports?		%
c. What was the total expenditures in this establishment in 2014? (Total expenditure includes all operational costs, such as materials, machinery equipment, manpower wages cost, etc.)s		RM

20.5. Please indicate the average yearly expenditure over the 4 year period (2011-2014) compared to total expenditure, on the following activities. *(**Select** on the scale 0 to 6, where 0=None; 1=very low (1%-10%); 2=low (11%-20%); 3=moderate (21%-30%); 4 =significant (31%-40%); 5 = high (41%-50%); 6=very high (above 50%)*

Expenditure	None	Very low					Very high
a. Expenditure on in-house R&D, including manpower wages cost, materials, travel, facilities, and equipment	0	1	2	3	4	5	6
b. Expenditure to acquire any licenses to use intellectual property (e.g. patents, designs, know-how)	0	1	2	3	4	5	6
c. Expenditure to purchase any specialized consulting services from other enterprises or organisations (e.g., research, design, engineering, IT, management, quality, safety)	0	1	2	3	4	5	6
d. Expenditure to sponsor or fund projects (research, technology) at a university or other institute	0	1	2	3	4	5	6
e. Expenditure to purchase or acquire reports or other outcomes of projects (research, technology, business) with industry, university or government or purchase other information sources (printed journals, on-line information, databases)	0	1	2	3	4	5	6

20.6. Please indicate the level of yearly average revenue over the 4 year period (2011-2014) compared to total revenue, on the following activities. *(**Select** on the scale 0 to 6, where 0 = None; 1 = very low (1%-10%); 2 = low (11%-20%); 3 = moderate (21%-30%); 4 = significant (31%-40%); 5 = high (41%-50%); 6 = very high (above 50%)*

Revenue	None	Very low					Very high
a. Revenue from selling in-house R & D capabilities to other firms	0	1	2	3	4	5	6
b. Revenue from selling any licenses for intellectual property (e.g. patents, royalties, designs, know-how)	0	1	2	3	4	5	6
c. Revenue from selling specialised consulting services (e.g. research, design, engineering, IT management, quality, safety)	0	1	2	3	4	5	6
d. Revenue from research collaboration projects (research, technology) along with a university or other institute	0	1	2	3	4	5	6
e. Revenue from selling reports or other outcomes of projects (research, technology) to others in industry, university, or government or sell any other information (printed journals, on-line information, databases)	0	1	2	3	4	5	6

20.7. Over the 4 year period (2011-2014), please indicate the level or number of each of the following activities.
(Please tick only one per activity)

Activity	None	Number					
		1-3	4-6	7-9	10-12	13-15	> 15
a. Numbers of patents (design, utility or plant) applied	☐	☐	☐	☐	☐	☐	☐
b. Numbers of patents granted	☐	☐	☐	☐	☐	☐	☐
c. Numbers of copyright, trademark, industrial design or integrated circuit (IC) layout design	☐	☐	☐	☐	☐	☐	☐
d. Numbers of joint venture or alliances to generate R & D	☐	☐	☐	☐	☐	☐	☐
e. Numbers of R & D spin-out into a new venture	☐	☐	☐	☐	☐	☐	☐
f. Numbers of projects (research, technology) with industry, university or government	☐	☐	☐	☐	☐	☐	☐
g. Numbers of technical papers (Scientific paper creating new knowledge/practise)	☐	☐	☐	☐	☐	☐	☐

Business Environment

21.0. Please evaluate the business environment between 2011 to 2014.
*(**Select** on the scale 1 to 5, where 1=strongly disagree; 2=disagree; 3=neither agree nor disagree; 4=agree; 5=strongly agree*)

Business environment	Strongly disagree				Strongly agree
a. Technology in this product or service area is changing rapidly	1	2	3	4	5
b. Customer preferences are constantly changing	1	2	3	4	5
c. Economic conditions are rapidly changing	1	2	3	4	5
d. New rules and regulations are often introduced	1	2	3	4	5
e. Overall the business environment is changing rapidly	1	2	3	4	5

Knowledge Sharing

22.0. Please tell us the industry sectors with whom you most frequently acquire and disseminate knowledge. Select up to THREE (3) top sectors under each column heading.

Industry Sector (Product/Service/Activity)	Most Frequently Acquire Knowledge From (tick up to 3 boxes)	Most Frequently Disseminate Knowledge To (tick up to 3 boxes)
Agriculture (Crops, Livestock, Fishing)	☐	☐
Food Processing	☐	☐
Chemicals	☐	☐
Petroleum (including Oil and Gas)	☐	☐
Pharmaceuticals	☐	☐
Rubber and Plastics Products	☐	☐
Wood-Based Products	☐	☐
Fabricated Metals	☐	☐
Automotive	☐	☐
Transport Equipment	☐	☐
Textile, Apparel and Footwear	☐	☐
Electrical and Electronic	☐	☐
Machinery and Equipment	☐	☐
Education Services (Tertiary)	☐	☐
Transportation Services (Ports, Airports, Shipping)	☐	☐
Finance Services (Head Offices)	☐	☐
Tourism Services	☐	☐
Telecommunications and Courier Services	☐	☐
Health Services	☐	☐
IT Services (e.g. computing)	☐	☐
Business Services (including management and engineering)	☐	☐
Wholesale and Retail Trade	☐	☐
Construction	☐	☐
Biotechnology based products and services	☐	☐
Nanotechnology based products and services	☐	☐

23.0. Between 2011-2014, did your establishment **collaborate with other organisations/institutions** in the following activities?

*(Over the period (2011-2014), please **select** on the scale 1 to 5, where N/A=Not applicable; 1=very low collaboration (one-off collaboration-small project); 2=low collaboration (between 2-3 small projects); 3=moderate collaboration (between 2-3 medium projects); 4=high collaboration (between 2-3 large projects); 5=very high collaboration (more than 3 large projects)*

[Note: Small project = 1 – 6 months duration; medium project = 7 – 12 months duration; large project = more than a year]

Research and development – *to develop technologically new or improved products, processes, services or software.*	**N/A**	**Very low collaboration**				**Very high collaboration**
a1. Other units in the establishment group	☐	1	2	3	4	5
b1. Suppliers	☐	1	2	3	4	5
c1. Customers	☐	1	2	3	4	5
d1. Competitors	☐	1	2	3	4	5
e1. Universities, other educational or government research institutions	☐	1	2	3	4	5
Design/engineering – including industrial, layout, product, process and service design specifications for production and delivery	**N/A**	**Very low collaboration**				**Very high collaboration**
a2. Other units in the establishment group	☐	1	2	3	4	5
b2. Suppliers	☐	1	2	3	4	5
c2. Customers	☐	1	2	3	4	5
d2. Competitors	☐	1	2	3	4	5
e2. Universities, other educational or government research institutions	☐	1	2	3	4	5
Knowledge management – operation of formal procedures for acquiring, using or sharing knowledge	**N/A**	**Very low collaboration**				**Very high collaboration**
a3. Other units in the establishment group	☐	1	2	3	4	5
b3. Suppliers	☐	1	2	3	4	5
c3. Customers	☐	1	2	3	4	5
d3. Competitors	☐	1	2	3	4	5
e3. Universities, other educational or government research institutions	☐	1	2	3	4	5
Employee skills upgrading – including new training programs for upgrading employee capabilities	**N/A**	**Very low collaboration**				**Very high collaboration**
a4. Other units in the establishment group	☐	1	2	3	4	5
b4. Suppliers	☐	1	2	3	4	5
c4. Customers	☐	1	2	3	4	5
d4. Competitors	☐	1	2	3	4	5
e4. Universities, other educational or government research institutions	☐	1	2	3	4	5
Market intelligence – market research, business or technology scanning to inform business planning	**N/A**	**Very low collaboration**				**Very high collaboration**
a5. Other units in the establishment group	☐	1	2	3	4	5
b5. Suppliers	☐	1	2	3	4	5
c5. Customers	☐	1	2	3	4	5
d5. Competitors	☐	1	2	3	4	5
e5. Universities, other educational or government research institutions	☐	1	2	3	4	5

Assistance and Support

24.0. Please indicate the level of **technical support** your establishment received from the following institutions.

(Select on the scale 1 to 5, where 1=no support; 2=little support; 3=moderate support; 4=strong support; 5=very strong support)

Technical support includes information and advice on improvement of existing products, process or services (including productivity), research, commercialisation and technology acquisition.	**Did you seek assistance?**		**Level of support received**				
	No	**Yes**	**No support**				**Very strong support**
a. Federal ministry or agency	☐	☐➔	1	2	3	4	5
b. Local or State Government	☐	☐➔	1	2	3	4	5
c. Public university or research institute	☐	☐➔	1	2	3	4	5
d. Private university or research institute	☐	☐➔	1	2	3	4	5
e. Non-governmental organisations (NGO)	☐	☐➔	1	2	3	4	5
f. Industry association	☐	☐➔	1	2	3	4	5
g. Financial Institutions (including microfinance institutions)	☐	☐➔	1	2	3	4	5

24.1. Please indicate the level of **business development support** your establishment received from the following institutions.

*(**Select** on the scale 1 to 5, where 1=no support; 2=little support; 3=moderate support; 4=strong support; 5=very strong support)*

Business development support includes information and advice on strategic management of business planning, market development, trade information, business opportunities, branding, packaging, labelling and image. **(Note: Exclude monetary assistance)**	**Did you seek assistance?**		**Level of support received**				
	No	**Yes**	**No support**				**Very strong support**
a. Federal ministry or agency	☐	☐➔	1	2	3	4	5
b. Local or State Government	☐	☐➔	1	2	3	4	5
c. Public university or research institute	☐	☐➔	1	2	3	4	5
d. Private university or research institute	☐	☐➔	1	2	3	4	5
e. Non-governmental organisations (NGO)	☐	☐➔	1	2	3	4	5
f. Industry association	☐	☐➔	1	2	3	4	5
g. Financial Institutions (including microfinance institutions)	☐	☐➔	1	2	3	4	5

24.2. Please indicate the level of **<u>operational support</u>** your establishment received from the following institutions.
*(**Select** on the scale 1 to 5, where 1=no support; 2=little support; 3=moderate support; 4=strong support; 5=very strong support)*

<u>Operational support</u> includes information and advice on standards, technical requirements, import or export regulations, ICT, e-commerce, mobile-commerce, e-business, finance, accounting and taxation (advice or referral). **(Note: Exclude monetary assistance)**	**Did you seek assistance?**		**Level of support received**				
	No	**Yes**	**No support**				**Very strong support**
a. Federal ministry or agency	☐	☐➔	1	2	3	4	5
b. Local or State Government	☐	☐➔	1	2	3	4	5
c. Public university or research institute	☐	☐➔	1	2	3	4	5
d. Private university or research institute	☐	☐➔	1	2	3	4	5
e. Non-governmental organisations (NGO)	☐	☐➔	1	2	3	4	5
f. Industry association	☐	☐➔	1	2	3	4	5
g. Financial Institutions (including microfinance institutions)	☐	☐➔	1	2	3	4	5

24.3. Please indicate the level of **skill development support** your establishment received from the following institutions.
*(**Select** on the scale 1 to 5, where 1=no support; 2=little support; 3=moderate support; 4=strong support; 5=very strong support)*

Skill development support includes information and advice training, education and skills upgrading.	**Did you seek assistance?**		**Level of support received**				
	No	**Yes**	**No support**				**Very strong support**
a. Federal ministry or agency	☐	☐➔	1	2	3	4	5
b. Local or State Government	☐	☐➔	1	2	3	4	5
c. Public university or research institute	☐	☐➔	1	2	3	4	5
d. Private university or research institute	☐	☐➔	1	2	3	4	5
e. Non-governmental organisations (NGO)	☐	☐➔	1	2	3	4	5
f. Industry association	☐	☐➔	1	2	3	4	5
g. Financial Institutions (including microfinance institutions)	☐	☐➔	1	2	3	4	5

24.4. Please indicate the level of **financial assistance for business development** your establishment received from the following institutions. *(**Select** on the scale 1 to 5 on the level of assistance, where 1=no support; 2=little support; 3=moderate support; 4=strong support; 5=very strong support)*

Financial support	**Did you seek assistance?**		**Level of support received**				
	No	**Yes**	**No support**				**Very strong support**
a. Government	☐	☐➔	1	2	3	4	5
b. Industry association	☐	☐➔	1	2	3	4	5
c. International agency	☐	☐➔	1	2	3	4	5
d. Financial institutions (including microfinance institutions)	☐	☐➔	1	2	3	4	5
e. Other financial intermediaries (venture capital, angel investors, etc.)	☐	☐➔	1	2	3	4	5
f. Philanthropist	☐	☐➔	1	2	3	4	5
g. Non-Governmental Organisations (NGO)	☐	☐➔	1	2	3	4	5

24.5. To what extent does your establishment utilise the following **<u>technology for business development</u>**.
*(**Select** on the scale 1 to 5 of level of usage, where N/A=Not applicable; 1=no usage; 2=low usage; 3=moderate usage; 4=high usage; 5=extensive usage)*

Technology	**N/A**	**No usage**				**Extensive usage**
a. Biotechnology	☐	1	2	3	4	5
b. Nanotechnology	☐	1	2	3	4	5
c. E-commerce	☐	1	2	3	4	5
d. Mobile-commerce (mobile applications)	☐	1	2	3	4	5
e. Social media	☐	1	2	3	4	5
f. Cloud computing	☐	1	2	3	4	5
g. 3D printing	☐	1	2	3	4	5
h. Big data analytics	☐	1	2	3	4	5
i. Internet of things	☐	1	2	3	4	5
j. Others (please specify): _____	☐	1	2	3	4	5

25.0. Please state your current position in the organisation: _____

26.0. Please specify the postcode of your company in Malaysia.

Appendix Chapter 1.2

Technical notes for Structural Equations Modelling (SEM) method

SEM will be employed to examine the interrelationships between the key k-inputs, k-transformation and k-outputs of firms. The multi-dimensional relationships is modelled using the SEM found in Jöreskog and Sörbom (1982) and is provided below.

Consider the latent dependent and independent variables as random vectors $\eta' = (\eta_1, \eta_2, \ldots . \eta_m)$ and $\epsilon' = (\epsilon_1, \epsilon_2, \ldots . \epsilon_n)$ respectively with the following system of linear structural relations:

$$\eta = \beta\eta + \Gamma\epsilon + \zeta, \qquad (1)$$

where β (mxm) and Γ (mxn) are coefficient matrices and $\zeta^1 = (\zeta_1, \zeta_2, \ldots \ldots . \zeta_m)$ is the random vector of residuals. The unobserved latent variables captured by vectors η and ϵ are measured by $y' = (y_1, y_2, \ldots \ldots . y_p)$ and $x' = (x_1, x_2, \ldots . x_q)$ and y and x are observed vectors such that:

$$y = \Lambda_y\eta + \mu, \text{ and} \qquad (2)$$

$$x = \Lambda_x\zeta + \delta \qquad (3)$$

where μ and δ are vectors of measurement errors in y and x and these measurement errors are assumed to be uncorrelated with η, ϵ and $\zeta; \Lambda_y\ (pxm)$ and $\Lambda_x\ (qxn)$ are coefficient matrices.

SEM is a generalisation of many familiar techniques and is similar to multiple regression but it is stronger as it takes the following into consideration: "the modelling of interactions, correlated independents, measurement error, correlated error terms, multiple latent independents each measured by multiple indicators, and one or more latent dependents also each with multiple indicators" (Garson, 2006, p. 5). Benefits of SEM in comparison to multiple regression analysis include assumptions which are more accommodating.

Bollen and Long (1993) highlighted that SEM compared to other multivariate techniques is able to study relationships of a series of dependence concurrently. The common limitation of other multivariate techniques is that these techniques can only investigate one relationship at a time (Hair et al., 2010). SEM is a technique that can evaluate both measurement properties and assess the core theoretical connections (Hair et al., 2010). This confirmatory method offers a means for evaluating and modifying theoretical models (Anderson & Gerbing, 1988).

SEM using the partial least Squares (PLS) is a component based SEM technique and is appropriate to conduct data analysis in this research for the following reason: First, PLS has the ability to account for measurement errors of latent constructs and to examine the significance of structural model simultaneously. Second, PLS is appropriate for complex models where large set of relationships among constructs and sub-constructs are examined (Wold, 1981). Third, PLS has the flexibility on modelling second-order constructs and formative constructs (Chin, 1998).

The software package Smart-PLS, Version 2.0 (Ringle, Wende and Will, 2005) is used to perform data analysis. A PLS model is analysed on two stages. First, the measurement model is tested to ensure reliability and validity. Measurement properties of multi-item constructs, including reliability, convergent and discriminant validity are examined by conducting confirmatory factor analysis using PLS. Second the proposed structural model is analysed for hypothesis test and justification.

There is a two-step process using PLS-SEM as suggested by Anderson and Gerbing (1988):

STEP 1: The assessment of the measurement model

The measurement model shows the relationship between the latent constructs and the items measuring each construct. In this study, both reflective and formative measures were considered and as such the assessment of the measurement model has to be done separately (Hair et al., 2013). The quality of the measurement model in terms of reliability and validity can be assessed by testing its internal consistency, indicator reliability, convergent validity and discriminant validity (Lewis, Templeton, & Byrd, 2005). Each of the latent construct should be unidimensional to prove internal consistency.

Reliability tests are conducted to assess an instruments ability to measure what it is designed to measure consistently. Cronbach's alpha coefficient is among the most regularly used indicators of internal consistency and the Cronbach alpha coefficient of a scale is recommended to be above the value of 0.7 (Pallant, 2001). Total Cronbach's Alpha is calculated based on the following equation (see Equation 1):

$$\alpha = m_w\left(\sum_s \lambda_s^{1/2} - 1\right) / \sum_s \lambda_s^{1/2}(m_w - 1), \qquad (1)$$

with λ_2 the s^{th} diagonal element of Λ as computed in the Orthonormalisation step during the last iteration (Pallant, 2001).

The second reliability measure is the Raykov's reliability rho (ρ), also known as the reliability rho or composite reliability. The tests assume "that a single common factor underlies a set of variables" (Raykov, 1998, p. 2). Raykov's composite reliability is as follow (see Equation 2):

$$CR = \frac{(\sum\lambda)^2}{(\sum\lambda)^2 + \sum \mathrm{var}(\varepsilon_i)} \qquad (2)$$

The convergent validity which determines that the multiple items are measuring the same concept is obtained by examining the outer loadings for indicator reliability and average variance extracted (AVE). The AVE measures the overall amount of variance in the indicators that can be explained by the latent construct should exceed 0.5 in all cases (Hair, Black, Babin, & Anderson, 2010).

For discriminant validity of the measures that is the extent to which constructs differ and measure distinct concepts, Fornell & Larcker (1981) recommended that the AVE for any two constructs should be greater that the squared correlation estimate between two constructs. This study will also conduct discriminant validity as proposed by Bagozzi et al. (1991) and Mackenzie et al. (2011) where these authors highlighted that the discriminant validity for any pair of constructs should be measured by constraining the correlation between the two constructs to the value of 1 and the difference between the chi-square results of constrained and unconstrained models is assessed. The variance extracted estimate is given by the formula (see Equation 3):

$$\rho_{vc}(n) = \frac{\sum\lambda_i^2}{\sum\lambda_i^2 + \sum\theta_i} \qquad (2)$$

In this study, the type of measurement model that is reflective or formative measurement is considered as many studies in the past have paid little attention on the type of measurement models (Petter, Straub, & Rai, 2007). Not recognising this limitation can result in measurement problems and model misspecification, leading to inaccurate policy intervention strategies (Petter et al., 2007). It is for this reason that this study conceptualised the constructs as either formative or reflective measurement and also considered the use of higher order latent variable models.

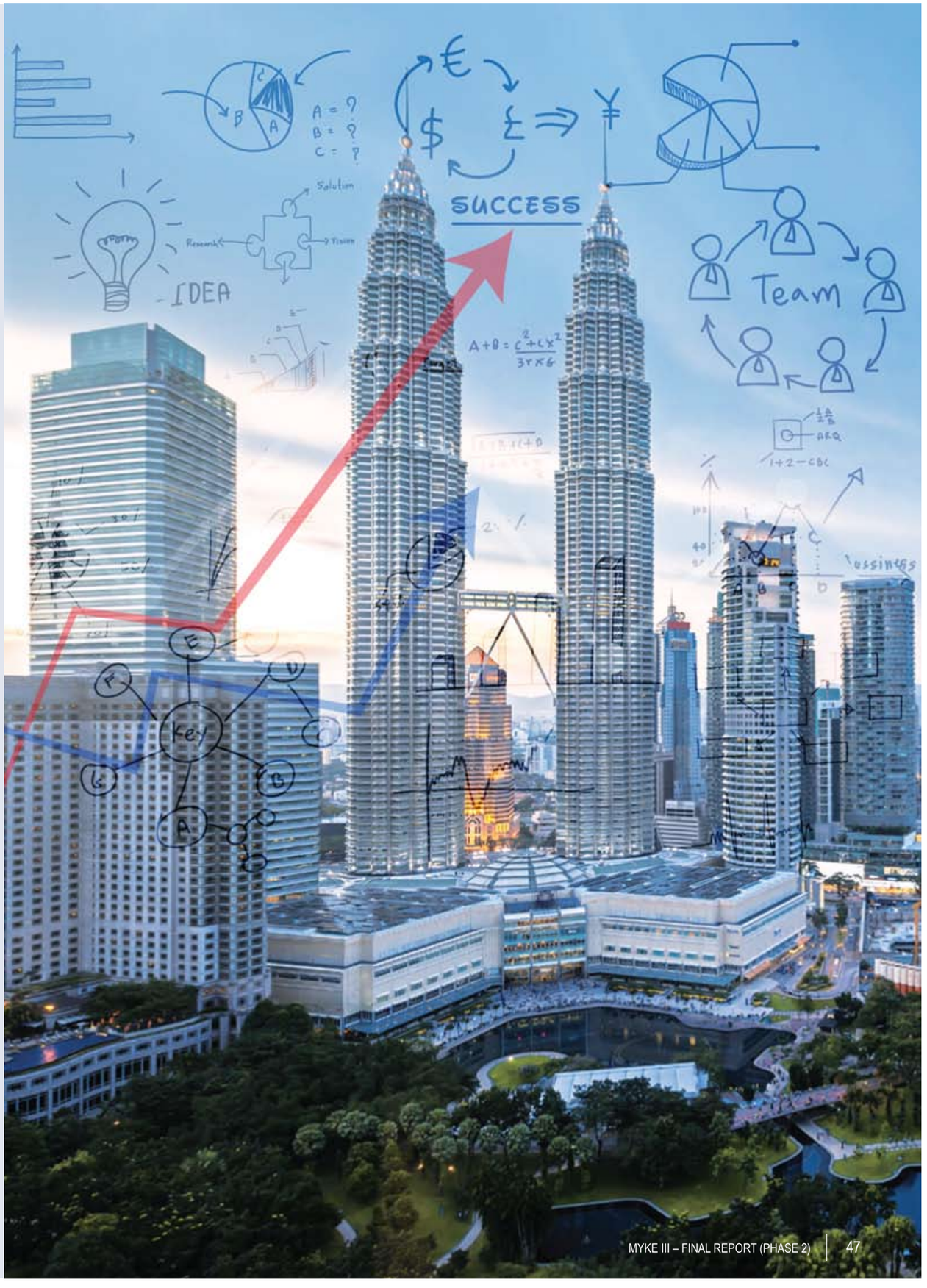
STEP 2: the assessment of the structural model

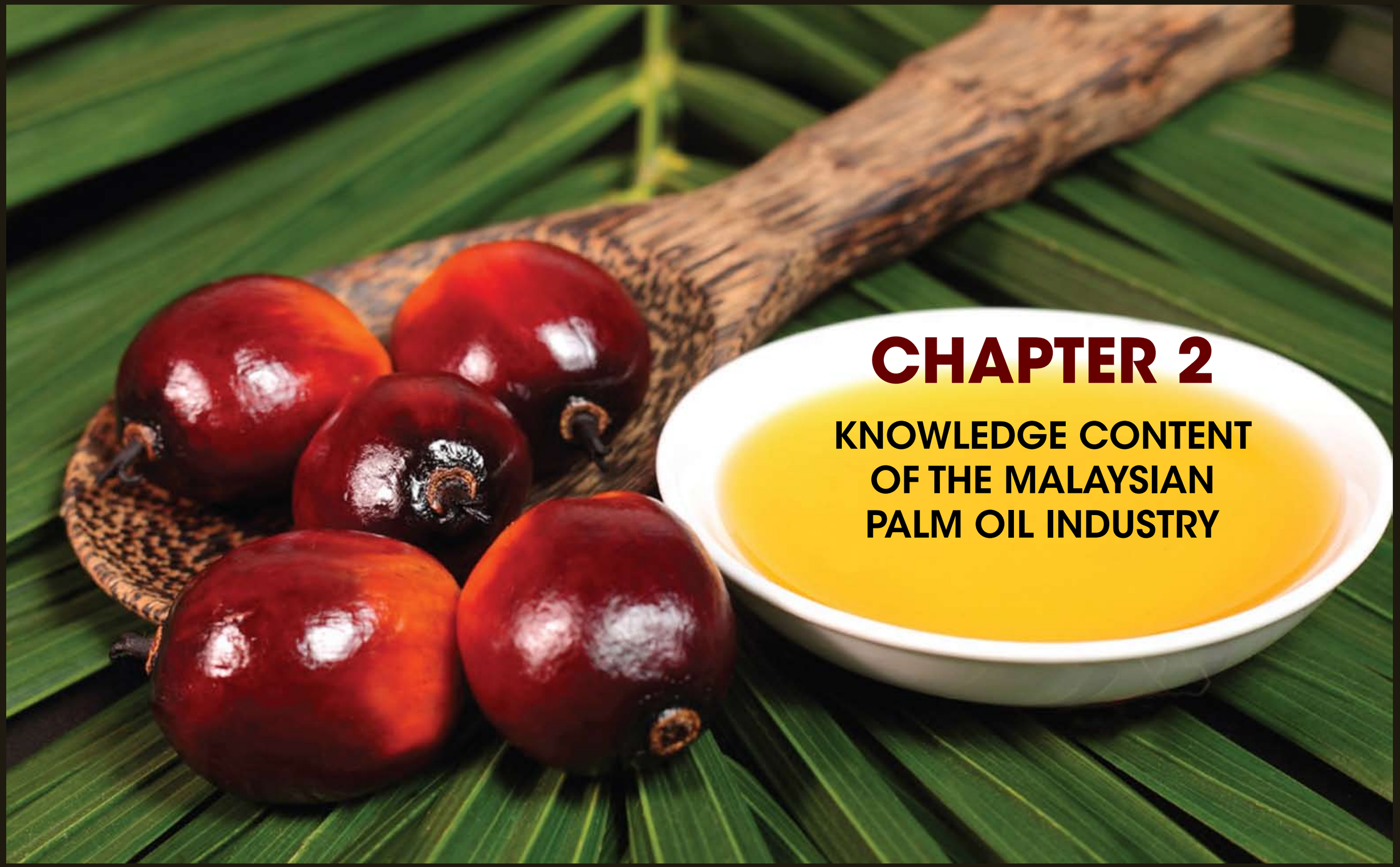
With the confirmed measurement model, the structural relationship between factors will be examined. The validity of the structural model can be established by evaluating each endogenous latent variable's coefficient of determination. The collinearity among the predictor constructs was tested using the VIF and the VIF values are all below 5 indicating that collinearity is not an issue in the structural model. The path coefficient in the structural model will be estimated using a distribution-free bootstrapping procedure and inferences will be drawn based on the critical ratio values associated with each path.

The focus of the study is to identify potentially significant relationships rather than confirming relationships supported by prior research. As such, a test for statistical power using the effect size index is important (Henseleret al., 2009), given below:

$$f^2 = \frac{(R^2included - R^2excluded)}{(1 - R^2excluded)}$$

The f^2 reflects whether a predictor latent variable has a weak, medium or strong effect on the structural model (Henseleret al., 2009). The f^2 -values of 0.02, 0.15 and 0.35 are conventional for low, medium and high-level effects, respectively (Cohen, 1992).





CHAPTER 2

KNOWLEDGE CONTENT OF THE MALAYSIAN PALM OIL INDUSTRY

CHAPTER 2
Knowledge Content of the Malaysian Palm Oil Industry

2.0 Introduction

The palm oil industry is a major contributor to the Malaysian economy – it accounts for 7.7% of the nation's total exports in 2015 (Department of Statistics Malaysia, 2016). The industry also contributes 39% of global palm oil production and 44% of world exports (Malaysian Palm Oil Council [MPOC], 2016). Palm oil plantations in Malaysia are amongst the best managed globally. Close to 60% are managed by private enterprises, a majority by large corporations. Some of the corporations are active in both upstream and downstream industries. Around 24.8% of the plantation is under the oversight of FELDA and FELCRA and the remaining 13.6% are managed by small holders.

To ensure the palm oil industry was developing its knowledge content, the Malaysian government established the Palm Oil Research Institute of Malaysia (PORIM) in 1979. In 2000, the Malaysian Palm Oil Board (MPOB) was established by merging PORIM and the Palm Oil Registration and Licensing Authority (PORLA). Through this initiative, research and development in palm oil breeding, palm oil nutrition and potential oleo-chemical use was intensified and a steady stream of commercial applications was introduced to the market. This also resulted in the development of a wide range of downstream palm oil industries.

Over the last decade, the palm oil industry has come under intense competition due to the emergence of Indonesia as a major player in the palm oil industry. In addition, palm oil experienced intense competition from other oils, such as corn oil, canola oil, and sunflower oil as healthier alternatives for edible oil. The negative publicity of palm oil's effects on the health of its consumers further compounded the adverse impacts on the palm oil industry.

To ensure the industry retains its competitive position globally, the industry must endeavour to move up the knowledge and innovation value chain. Innovation is critical to ensure the quantum and quality of supply of palm oil is strong to support a wider spectrum of down-stream industries. In this chapter, we assess the knowledge ecosystems of the palm-oil industry using the MYKE-III knowledge ecosystem model for a sample of 503 firms operating in Malaysia. From the sample, 296 are large firms, 207 are SMEs, 500 local and 3 foreign firms. The palm-oil industry consists of planting, harvesting, and support services for the palm oil plantations.

The chapter is organized as follows: in Section 2.1 a description of a knowledge ecosystem of agriculture plantations in an advanced country is provided. In Section 2.2, a description of the knowledge ecosystem for the Malaysian palm oil industry. In Section 2.3 the key strengths and gaps in the Malaysian palm oil knowledge ecosystem are discussed. In Section 2.4, key recommendations to improve the knowledge ecosystem of the Malaysian palm oil industry are provided. In Section 2.5, concluding remarks are given.

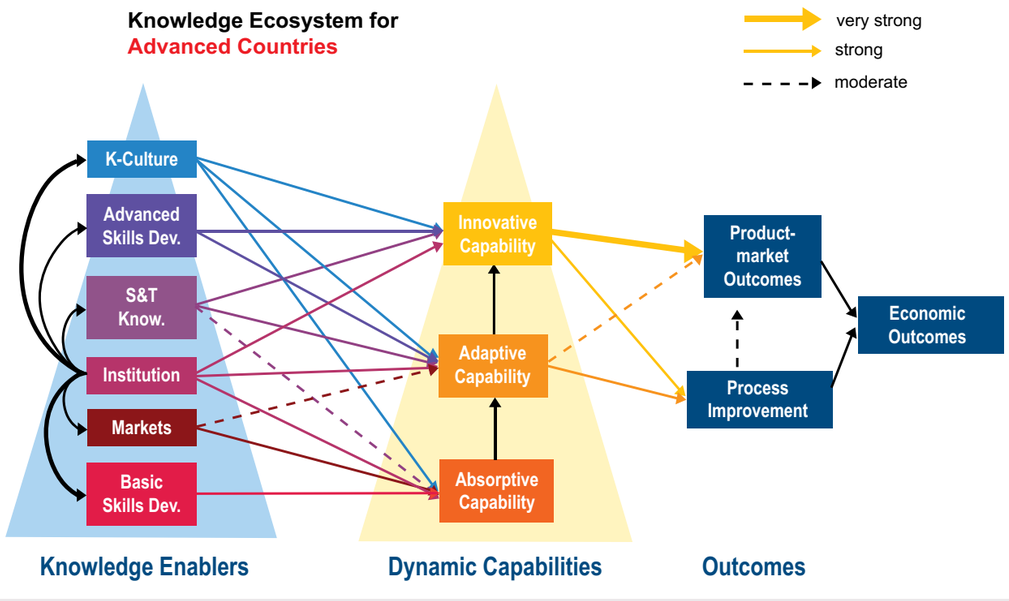
2.1 Knowledge Ecosystem in an Advanced Economy

The relationship between the knowledge enablers, dynamic capabilities and economic outcomes for advanced countries is shown in Figure 2.1. The ecosystem shows that the knowledge enablers for all three components of the dynamic capability are very strong. Institutions (government agencies, trade associations and universities) in these countries have a dual role of ensuring the other enablers are strong to support the dynamic capability components; at the same time directly influencing the dynamic capability components. Next, key components of the knowledge ecosystem for an agriculture plantation in advanced countries are discussed.

❑ *Knowledge Context*

In many advanced countries, agriculture policies and directions are harmonized with global best practices and standards. These countries have well established standards, regulations and policies to guide the industry to meet the needs of the global market.

Figure 2.1: Knowledge Ecosystem for the Agriculture Industry in an Advanced Country



Most of these institutions, especially government agencies, have in-house experts on a wide range of areas pertaining to agriculture crops. These experts provide valuable information and knowledge to address issues related to the type of science and technology needed to improve the quality of the crops; systems and processes the firms should adopt to meet environmental and health standards; other strategies to mitigate both internal and external risks to the industry. Strong adherence and compliance to global best practices and standards requires firms to adapt to a knowledge culture that nurtures absorptive, adaptive, and innovative capabilities of firms and workers; hence promoting a culture of continuous improvement. *Refer to* ***Case-Study 2.1: Food Standards Australia-New Zealand*** for further insight in establishing a sound knowledge environment for the agriculture industry. The case illustrates how Australia and New Zealand enabled their agriculture products to penetrate the global markets and continuously maintain their global competitiveness.

❑ *Knowledge Institutional Systems*

Strong institutional framework is a key driver of continuous improvement of the knowledge ecosystem of agriculture industries in many advanced countries. Close cooperation among government agencies, industry associations and educational institutions results in a multi-stakeholder partnership model that enables the industry to develop 'holistic' short-term, medium-term, and long-term strategic plans to ensure systematic development of the agriculture industry. These strategic plans incorporate an implementation strategy, clearly articulating key performance indicators to be met over a specified time period. The plans also identify key research focus areas of development that will lead to new breakthroughs which enable the industry to intensify process improvement and new product development. The milestones of the programs and outcomes of the implementation strategies are tracked and reported on a regular basis. Refinements to the strategies, policies and milestones are undertaken regularly to ensure the plan meets the objective of transforming the industry into a knowledge-intensive and a globally competitive industry. *Refer to* ***Case-Study 2.2: Growing Forward 2 (2013-2018): A 5 year Federal-Provincial-Territorial initiative***, a comprehensive strategic plan that sets the tone for the development of the Canadian agriculture industry.

❑ *Knowledge Capital*

In most advanced countries where agriculture is an important economic driver, significant resources are channelled to develop human capabilities and competencies. This is reflected in the strong impact basic skills and S&T knowledge have on absorptive capability; and S&T and advanced knowledge on adaptive capability and innovative capabilities. In many of these countries, numerous incentives are provided to enhance the knowledge capital of the industry, such as providing a wide range of training, workshops and courses to help the workforce to up-skill and continuously improve their skillset. Incentives are also provided to encourage the youth to select agriculture as their preferred employment of choice. *Refer to* ***Case-Study 2.3: UK-Young Entrance Support Schemes*** to encourage young talent to join the agriculture industry.

❑ *Knowledge Competence*

Various courses and training programs (certificate, diploma and tertiary qualifications) are in place for the workers to professionalise their expertise. These countries take a holistic perspective to skills training and continuous upgrading of the knowledge base of the workforce. Skills competency frameworks are in place in most advanced countries for the agriculture industry. The skills competency frameworks cover basic skills to post-doctoral training to meet the full breadth and depth of trained personnel needed to ensure the industry remains knowledge intensive and globally competitive. *Refer to* **Case-Study 2.4: Wegeningen University, World's Number 1 University for Agriculture Education- Holland**, the establishment of a leading educational institution that contributes to a steady supply of highly talented personnel for the agriculture industry in Holland.

❑ *Knowledge Learning and Transfer*

A key feature of the knowledge ecosystem in advanced countries is the implementation of strategies to encourage knowledge learning and transfer among government agencies, industry, and educational institutions. The strong partnerships between colleges and universities with industry are a strong feature that enables educational institutions to ensure the courses are relevant to the industry. Partnerships also enable university R&D activities to directly benefit the industry, especially SMEs who may not have the relevant expertise and R&D facilities to undertake cutting-edge research that may potentially enhance process improvement and new product development. One of the leading best practices in fostering strong university-industry partnership model is documented in ***Case-Study 2.5: Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTT) programs***, managed by the United States of America Department of Agriculture.

❑ *Knowledge Approach*

In many advanced countries, strong collaboration between industry, universities, Government Research Institutes (GRIs), and Centers of Excellence (CoEs) leads to new discoveries and innovations that contribute to the strategic development of the agriculture and complementary industries. In most advanced countries, a knowledge approach that is gaining immense popularity is the university-industry engagement modelled after the Fraunhofer philosophy. This philosophy provides a systematic and targeted approach in generating new breakthroughs and innovations that help enhance process improvements, product development, and open new revenue streams. A best practice of the Fraunhofer philosophy is ***Case-Study 2.6: Fraunhofer – Chile's Applied Research that meets the needs of the Agriculture industry.***

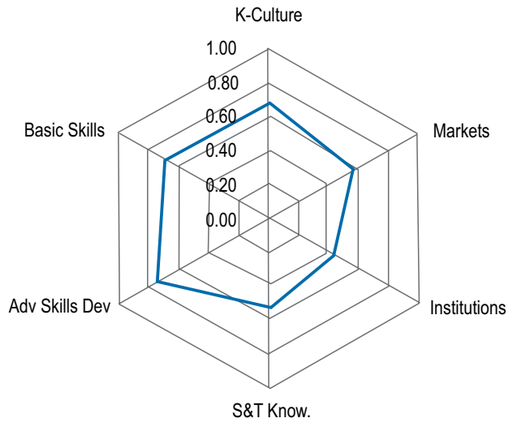
❑ *Knowledge Leverage*

One of the major challenges encountered by the agriculture community is access to information on support services provided by the various agencies and external stakeholders. This information includes regulations and best practice, expertise, research facilities, networks, and other support services. In most advanced countries, the agriculture community is provided valuable information (knowledge leverage) via two channels. The various government agencies make up the first channel, who have up-to-date and comprehensive online resources for the farming community. They also provide help-desk and consultancy services to the farming community. The second channel, key universities, colleges and institutes, are appointed to be the lead institutions to provide the agriculture community a wide range of services, information, and support. One such best practice is ***Case-Study 2.7: Agriculture and Food Laboratory, University of Guelph, Canada.***

Summary:

The analysis of the knowledge ecosystem of agriculture industry from the perspective of advanced country suggests that the knowledge environment, institutional framework for strategic development (knowledge ecosystem), knowledge capital, knowledge competencies, knowledge learning & transfer mechanism, and the knowledge leverage programs are important for the development of the dynamic capability of the industry. The enabling conditions are also important to ensure the development and flow from absorptive capability to adaptive and innovative capabilities of the firms in this industry to take place within the ecosystem. Sound absorptive, adaptive and innovative capabilities equip firms in the industry with tools to develop new process improvements and generate new product outcomes, leading to higher economic outcomes.

Figure 2.2: Knowledge Enablers for the Malaysian Palm Oil Industry

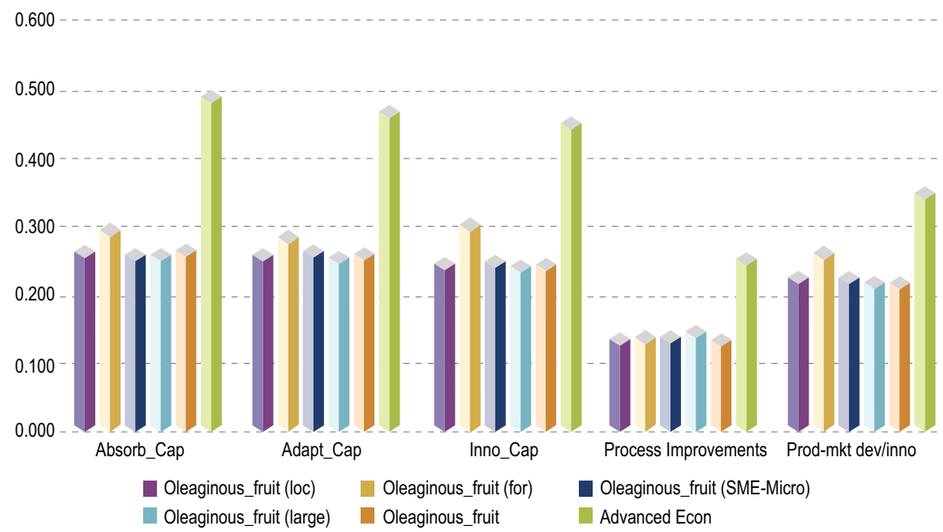


2.2 Knowledge Ecosystem of the Malaysian Palm Oil Industry

In this section, we provide a brief description of the knowledge ecosystem for the Malaysian palm oil industry. Figure 2.2 show the state of development of the knowledge enablers. All enablers are performing at the moderate level, with the exception of institutions, which scored below 0.5.

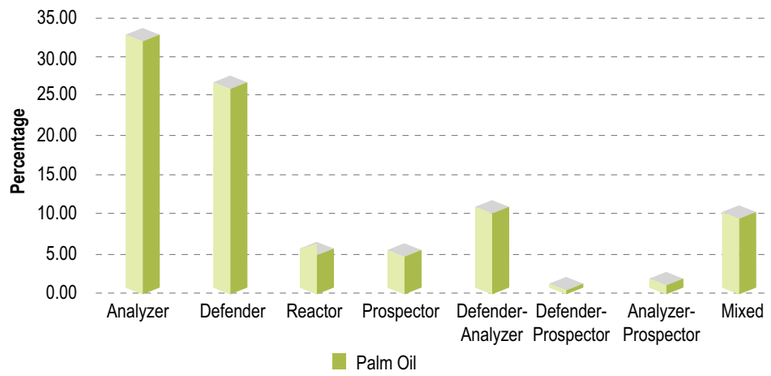
Figure 2.3 show the dynamic capability components, process improvement and product development in the Malaysian palm oil and that of a comparable agriculture industry from an advanced country. The dynamic capability components, process improvement, and product development were measured for large, SMEs, local, and foreign firms. The dynamic capability, process improvement, and product development for advanced countries were found to be significantly higher than that of the

Figure 2.3: State of the Dynamic Capabilities of the Malaysian Palm Oil Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

Figure 2.4: Strategic Posture of the Frms in the Malaysian Palm Oil Industry

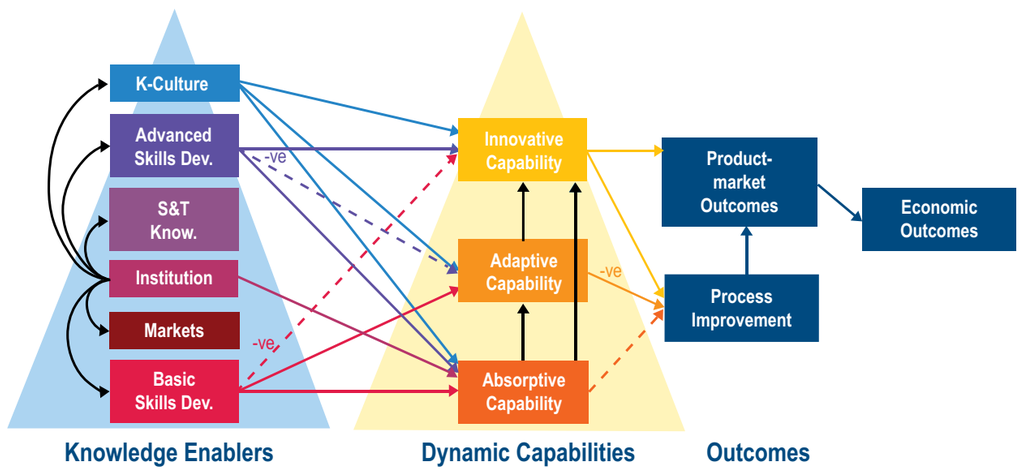


Malaysian palm oil industry. Within the Malaysian palm oil industry, foreign firms were found to have higher dynamic capability and product development than local firms. Larger firms have a slightly higher process improvement than SMEs.

The strategic postures of firms in the Malaysian palm oil industry are given in Figure 2.4. The figure show that a majority of firms are Analyser (over 33%), Defender (over 28%), and Defender-Analyser (12%) firms. Only 6% of the firms in the palm oil industry are Prospector firms. This suggests a small proportion of firms in the palm oil industry invest in path-breaking R&D and innovative endeavours.

The knowledge ecosystem for the palm oil industry is shown in Figure 2.5. The Malaysia palm oil ecosystem is found to be relatively weaker than the knowledge ecosystem of more advanced countries. One of the key features of the palm oil ecosystem is that institutions play a dominant role in developing the knowledge enablers; but, only directly influences the absorptive capability of the firms. The other enablers that support absorptive capability are basic skills development, advanced skills development and knowledge culture. The analysis suggests that key government institutions and institutions such as MPOB are at the fore-front of providing capability development programs (for both basic and

Figure 2.5: Knowledge Ecosystem of the Palm Oil Industry



advanced skills) to enhance absorptive capability. These institutions also endeavour to instil a culture of continuous improvement among all segments of the workforce.

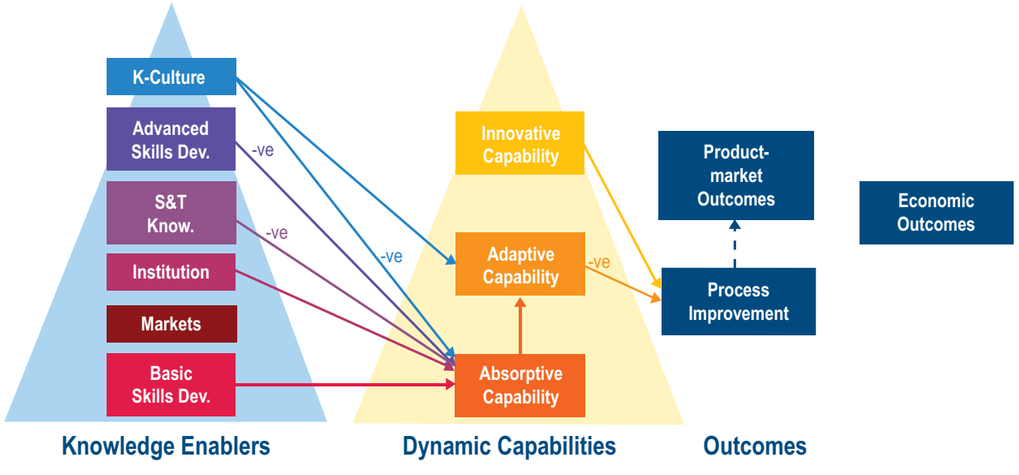
Given the importance of the palm oil industry to the Malaysian economy, resources have been channelled to key GRIs, universities, and large industry players to undertake R&D activities that will enhance process improvement and spur new product development in the palm oil industry. Hence, it is not surprising that advanced skills development and a knowledge culture have a positive impact on the innovative capabilities of the industry. The innovative and absorptive capabilities were also found to have positive impacts on process improvement. On the other hand, innovative capability was found to have a positive impact on product market development and this directly impacts economic outcomes.

One of the interesting features that emerged from the empirical analysis is the negative impact of basic skills development on innovative capability. This result suggests that firms that try to innovate based on basic skills development only, without other supporting pillars, will lead to inferior products. This has a noticeably adverse impact on the reputation of the industry. Furthermore, advanced skills have a negative impact on adaptive capability; and adaptive capability subsequently has a negative impact on the process improvement of the industry. This result is due to a shortage of technically competent staff at the middle level of operations in the industry. Shortage of technically competent staff prevents firms from undertaking modification and refinements of existing knowledge. Hence, firms are unable to improve the quality of their production processes based on an existing stock of knowledge.

The palm oil ecosystem was compared across the board for large and micro-SME firms, and the results of the multi-group analysis are presented in Figure 2.6. The results show that basic skills development, institutions, and knowledge culture have a greater impact on absorptive capability for larger firms than micro-SMEs. Knowledge culture has a strong impact on adaptive capability for larger firms than micro-SMEs. Innovative capability was found to have a more significant impact on process improvement for larger firms than that on of micro-SME firms.

On the other hand, S&T knowledge, advanced skills, and knowledge culture have a more significant impact on absorptive capability for micro-SMEs than larger firms. The impact of adaptive capability on process improvement was found to be more significant for micro-SMEs than for larger firms.

Figure 2.6: Knowledge Ecosystem for Palm Oil Large versus Palm Oil Micro-SME



2.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Palm Oil Industry

Based on analysis of the knowledge ecosystem of the palm oil industry, the key strengths and gaps of the ecosystem are provided in this section of the report.

There is strong support from the Malaysian government to develop the industry as a major revenue earner for the country; hence, the industry receives significant support from the government in terms of financing for R&D, infrastructure development, and capability development (for development of basic skills and research personnel).

- Malaysia hosts some of the leading research centres in palm oil.

- The major industry players undertake R&D to create new products and services.

- Key government agencies strongly promote palm oil and palm oil based products in the global markets with significant branding efforts;

- Global demand for palm oil is strong; and,

- The industry relies on foreign labour in the plantation sector; hence, the cost of production is low and globally competitive.

Key Gaps Palm Oil Knowledge Ecosystem:

- While the industry is a global player, the level of strategic planning, fore-sighting and sign-posting of future key areas of strategic development is not well articulated compared to competing agriculture crops in the developed countries such as corn-oil, canola oil, and sunflower oil. This is in part due to key institutions working in isolation and a lack of strong cooperation among key stakeholders in the industry.

- Most firms do not understand global trends and market intelligence, which form the source and level of competition from regional and global players. Many are highly dependent on foreign technology players and knowledge suppliers for information and knowledge for decision-making. There is a pattern of "lock-in" among some firms in the industry, especially micro-SME firms, and this hinders their innovative capacity

- The industry is unable to attract and retain skilled workers who are able to undertake higher value-adding activities and operations (e.g. use of Industry 4.0 systems) because firms are not willing to offer higher remuneration or provide a more conducive work environment. Instead, most firms prefer importing cheap labour from neighbouring countries. Hence, the jobs that have remained are labour intensive, classified as 3D jobs, lack career prospects, and do not have the appeal and prestige for the younger generation Malaysian workforce. Further cost (both explicit fixed and variable costs as well as opportunity costs) of skills training is high.

- The basic technical education in the agriculture industry has not kept pace with the changes taking place in the industry and the marketplace, especially with converging technology platforms and knowledge systems. There are very few TEVT and technical colleges that prepare graduates for the palm oil industry. Furthermore, the curriculum does not meet the needs of a fast changing industry. Proper assessment of core competencies of all segments of the workforce for the palm oil industry has not been undertaken. As such, there are gaps in the palm oil talent development strategy. This has resulted in a serious shortage of mid-level technical workforce and expertise. Shortage in this segment of the workforce has major adverse impacts on the knowledge ecosystem, which hinders the industry from building strong adaptive capability. This also prevents firms from translating their dynamic capabilities into process improvement and product development.

- The industry has a major challenge in attracting high calibre researchers, creative talent, and workers with specialized skills sets due to uncompetitive remuneration, highly bureaucratic research and work environment, and low levels of R&D funding relative to other industries such as manufacturing. The problem is further

exacerbated by weaknesses in the ecosystem that hinder strong partnerships and collaborations between the research community (universities and GRIs) and industry to undertake translational R&D initiatives.

- The regulatory environment is not well organized and accessing information for strategic decision-making via a 'one-stop-portal' is scarce. It is difficult for firms in the industry to get information or knowledge online. Even if the online portals are available, many of them are not updated on a regular basis; this impact the firms' ability to get the right information for strategic decision making.

- Knowledge sharing culture among firms in the palm oil industry is not as pervasive as those in more developed countries. One of the major challenges encountered by micro-SME firms is gaining support for R&D activities, access to expertise and research facilities. Many are also not part of the knowledge networks that provide them access to information on new technology, innovation, market intelligence and other resources that enhance their market competitiveness.

2.4 Recommendations to improve the Malaysian Plan Palm Oil Knowledge Ecosystem

The palm oil industry is a key contributor to economic wealth of Malaysia. Intense competition from countries such as Indonesia with a larger labour pool and competition from other substitute oils from more developed countries both pose major challenges for the palm oil industry. To ensure the viability and competitiveness of the Malaysian palm oil industry, the following recommendations are proposed to strengthen the knowledge ecosystem and knowledge content of the industry.

Recommendation 2.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Palm Oil Industry

- ❑ Global competitiveness of the palm oil will depend on the ability of the industry to meet global best practices and standards related to farming, harvesting, processing and selling palm oil. Two major concerns loom ahead for the palm oil industry. First is the concern of palm oil planting and harvesting on the natural environment. Second, the health hazard of palm cooking oil.

- ❑ To meet the global standards and best practices for environmental management and the health of consumers; the palm oil industry will be required to increase investment in talent development, infrastructure, technology, governance systems, monitoring, surveillance, and other support systems.

- ❑ Information on these standards and best practices should be easily available online to all firms; and support to adhere to these best practices should be made available to firms via industry associations and key government agencies.

- ❑ The industry should also invest in developing its own scientific and technical expertise on a wide range of issues related to S&T, environmental, health standards & regulations, and other risks associated with palm oil plantations.

Best Practice: ***Case-Study 2.1 - Food Standards Australia-New Zealand***

Recommendation 2.2: Enhance the Knowledge Institutional System of the Palm Oil Industry

- ❑ Establish an effective institutional framework for a more coordinated development of the palm oil industry, leveraging on a strong partnership model with all stakeholders (federal & state government agencies, industry associations, industry, community organisations, and NGOs) in the industry.

- ❑ Develop a strategic plan for the palm oil industry, clearly mapping the key focus areas of development over the next 20 years. The plan should clearly articulate the short-term, medium term, and long-term initiatives to develop a more robust and vibrant ecosystem. Key milestones, key performance indicators (KPIs), tracking and monitoring mechanisms should be incorporated to ensure the smooth implementation of the plan.

- ❑ The multi-stakeholder partnership model should ensure that firms, especially the SMEs have access to the necessary resources, support services, technology and networks to be able to enhance their reach and richness in their products and services, in the domestic, regional, and global markets.

Best Practice: ***Case-Study 2.2 - Growing Forward 2 (2013-2018): A 5 year Federal-Provincial-Territorial initiative***

Recommendation 2.3: Develop the Knowledge Capital of the Palm Oil Industry

- ❑ Intensify training in agriculture related courses and programs in high school, technical colleges, and polytechnics. Specifically, the Education Ministry can elect to strengthen the 'Sains Pertanian' subject at the PT3 and SPM level.

- ❑ Promote and provide access to certifications programs in agriculture through the various colleges and polytechnics for workers who do not have formal training or qualifications – this is an important way to up-skill and professionalise the training in the industry.

- ❑ Industry should be a key partner in the development of course and training programs - internships and work placements are core to the training.

- ❑ Establish research programs and doctoral courses in palm oil research in our universities, jointly with major industry players.

Best Practice: ***Case-Study 2.3 - UK-Young Entrance Support Schemes***

Recommendation 2.4: Develop the Knowledge Competency of the Palm Oil Industry

- ❑ Key priority areas of development should be developed in line with global demand conditions, especially in the food industry, cosmetics, biofuel and other areas. Attention should also be given to environmental issues pertaining to palm oil crops.

- ❑ Continue to support leading palm oil research centres in the country to find new high yield crops, develop more effective management of plantations, environmental-friendly palm oil plantation management, more effective technology for planting, harvesting and extraction of palm oil, health and nutritional effects of palm oil.

- Universities and research centres work in partnership with industry associations, industry (especially SMEs), community organisations and NGOs to promote sustainable development.

- To professionalise the workforce, training and education must develop core competencies for all levels of employment in the palm oil industry. This includes the incorporation of the following knowledge in all the skills development and certification programs: environmental-friendly cultivation, harvesting and management of palm oil plantation; eco-friendly ways of managing palm oil waste; the use of advanced technology and scientific knowledge to improve crop yield; and soft-skills such as effective communication, people management, entrepreneurial and leadership skills. The courses and training must incorporate the Industry4.0 framework to improve operation efficiency and global competitiveness of the palm oil industry.

- Establish a more holistic talent management strategy that incorporates data analytics to identify key mismatches in the skillsets of workers in the palm oil industry and establish Industry Centres of Excellence and Academic-industry Graduate Development Centre in training institutes, colleges, polytechnics and universities to ensure that the curriculum meet the needs of the industry and students have ready employment upon completion.

Best Practice: ***Case-Study 2.4 - Wegeningen University, World's Number 1 University for Agriculture Education***

Recommendation 2.5: Facilitate Knowledge Learning & Transfer within the Palm Oil Industry

- One of the most effective ways to ensure that knowledge and technology transfer takes place between universities and the farming communities is to develop a 'win-win' model; where industry and universities are provided incentives to work together on programs that are mutually beneficial. This includes universities, GRIs, and CoEs providing local palm oil industry support for R&D, business development and knowledge/technology transfer. These institutions can also play a role as "one-stop-centres", providing information and knowledge for the palm oil firms. These institutions can help in organizing regular workshops and training for industry. One of the spill-over benefits for the institutions is a close partnership with industry which will ensure the course curriculum is relevant to the needs of the industry and students trained in these institutions will have the necessary skills to be employed by these industries.

- One program to facilitate stronger engagement between institutes of education and the industry is the SBIR and STTT program in the USA. Based on this approach, the government allocates grants and other financial support to institutions with a clear KPI to assist and up-skill the local palm oil firms to become more knowledge and technology intensive. Institutions that are able to raise the level of knowledge and innovative capability of local firms are rewarded with higher allocations of financial support for scholarships, research grants, salary of experts, and research infrastructure development.

- Industries that provide financial support to universities for R&D, internships and work placements are given double-tax deductions and access to government grants. This scheme encourages greater participation between industry and universities in developing the next generation of knowledge intensive farming talent.

Best Practice: ***Case-Study 2.5 - Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTT) programs, United States of America Department of Agriculture.***

Recommendation 2.6: Incorporate an Innovative Knowledge Approach within the Palm Oil Industry

- The centres of excellence (CoEs), GRIs and universities in the palm oil should adopt the "Fraunhofer" philosophy to intensify translational and applied research.

- The key focus areas should be:
  - High yield and pest-resistant yield;
  - Use of advanced technology (nano-technology, nanomedicine, and bio-technology) for ensuring sustainable and eco-friendly plantation practices.
  - Use of advanced smart technology to reduce cost and improve operational efficiency.
  - Identify key bioactive compounds that will show the health benefits of palm oil and other compounds that will lead to new applications & downstream industries.
  - Development of new technology, informatics tools, and knowledge management systems that benefit the industry.

- Establish strong research collaboration between CoEs, GRIs, universities and industry with target outcomes to be achieved to include the following: higher levels of process improvement and product development via technology/knowledge transfer; increase the number of intellectual properties (IPs) and patents; commercialisation of IPs/patents; and creating new revenue sources from management services, workshops trainings and consultancy

Best Practice: ***Case-Study 2.6 – Fraunhofer Chile's Applied Research that meets the needs of the Agriculture industry***

Recommendation 2.7: Strengthen the Knowledge Leverage within the Palm Oil Industry

- Key research institutes (universities, GRIs and CoEs) can be important 'One-Stop Centre' for firms in the industry. The online portal can also be an important source of information for services such as access to financing, expertise, research infrastructure, new science & technology and discoveries related to the palm oil industry.

- The various universities, colleges, polytechnics and training institutes can be knowledge centres in the various localities providing advice on business development, new innovations and technology, market opportunities, networking and other resources that enhance knowledge content and business development.

- Align the KPIs and financial support for local education institutions to serve the firms and local communities in the palm oil industry, allowing them to build knowledge content and enhance their innovative capacity. To incentivise these institutions to be key enablers for knowledge dissemination and leverage for firms, financial support should be aligned to service provided to the local firms in terms of building knowledge content and moving up the innovation value chain.

Best Practice: ***Case-Study 2.7 - Agriculture and Food Laboratory, University of Guelph, Canada.***

2.5 Conclusion

This chapter provided valuable information on the state of the knowledge ecosystem for the Malaysian palm oil industry. The analysis highlighted some of the key strengths and gaps in the knowledge ecosystem. In particular, the study identified the key knowledge enablers that are strong and have enabled the industry to be a major player in the global palm oil market. The empirical analysis also identified some of the weaker links in the ecosystem and key reasons for these gaps in the ecosystem. In this chapter, we also discussed key policies and strategies to strengthen the knowledge enablers; so as to ensure that the dynamic capability components of the industry are raised to higher levels. Higher dynamic capabilities will translate into stronger process improvement and product development; further strengthening the knowledge content and economic performance of the industry.

Appendix for Chapter 2

Best Practice: Case-Study 2.1 - Food Standards Australia-New Zealand

Food Standards Australia-New Zealand is a leading bi-national independent statutory agency that develops and ensures industries meet global best practices pertaining food, food additives, food safety, labelling, genetically modified (GM) foods, and food traceability. Among the key objectives of this agency are:

- It ensures harmonisation of national best practices to global best practice - a key source of global competitiveness and market penetration into OECD countries;
- industry support to comply to standards and regulations and user guide – detailed website containing standards, policies and regulations are available;
- comprehensive information for consumers are provided on additives, chemicals in food, food allergies and intolerances, food safety and recalls, food technologies and novel food, GM foods, imported foods, labelling, nutrition and fortification and other food related information online;
- the agency is supported by a broad range of in-house experts with scientific skills to undertake risk analysis and appropriateness of regulatory measures; and
- The agency has scientific experts, who also contribute to scientific publications in the fields that are accessible to the global agriculture industry.

For more information: http://www.foodstandards.gov.au/

Best Practice: Case-Study 2.2 - Growing Forward 2 (2013-2018): A 5 year Federal-Provincial-Territorial Initiative, Agriculture and Agri-Food Canada

Agriculture and Agri-Food Canada is the agency responsible for ensuring that all the stakeholders (government agencies at the federal, provincial and local territories, industry associations, GRIs and educational institutions) work in close partnership to raise the knowledge content, dynamic capabilities and competitiveness of the Canadian agriculture industry. Close to C$30 billion was allocated to support programs that will transform the industry into one that was globally competitive. Under this plan the following programs were introduced:

- *AgriInnovation Program* – development of science & technology, development & commercialisation of new products and services in key priority areas.
- *Agri Marketing Program* – industry adopt food safety and traceability systems and a strategy to expand to new markets.
- *AgriCompetitiveness Program* – increase profitability in domestic and global markets by raising the quality of the products and reduce operational efficiency.
- *Cost-Share Programs* – introduce programs that allow provinces the flexibility to design and deliver programs that meet the needs of farming communities in the respective provinces; and helping farmers manage risk due to severe market volatility and natural disasters.
- *Business Risk Management Program* – introduce new innovative investment, stabilisation, insurance, natural disaster recovery programs and other new private & producer funded agriculture risk management tools.

For more information: http://www.agr.gc.ca

Best Practice: Case-Study 2.3 - UK-Young Entrance Support Schemes, United Kingdom

Young Entrants Support Schemes (YESS) is to encourage the younger generation to join the talented workforce in agriculture. YESS in UK has introduced a number of programs, among them grants for young entrants and a mentor-mentee program where established farmers act as coaches/mentors to provide guidance to new and young workers in the industry. The programs also undertake the following: provide a clear pathway to higher education as articulated from certificate to doctoral program in institutions of higher learning;

- curriculum for the program is designed collectively with key industry players, trade associations and universities (institutions) and aligned with national strategic priority industries – this is to ensure the program is relevant and meet the needs of the industry;
- job training, internships, apprenticeships and mentorship are key components in the education & training program so that graduates are job-ready;
- competitive remuneration, continuous improvement of the teaching and learning environment; access to high quality professional development programs for educators;
- publicity campaigns are coordinated with the industry to highlight the benefits of agriculture education in the local media, digital platforms and meetings; this includes showcasing the achievements of students to the community. By doing so, the publicity campaigns increase interests among the young talent to make this industry the preferred choice for their careers.

For more information: www.gov.uk/young-entrants-support-scheme

Best Practice: Case-Study 2.4 - Wegeningen University & Research, World's Number 1 University for Agriculture Education, Netherland

The Wegeningen University & Research is one of the top ranked universities in the world and rated the best university for agriculture and forestry studies. The university works closely with the agriculture community to provide education and training, including access to research expertise and facilities to industry. The programs are jointly designed with industry to ensure that they meet the job specifications and core competencies of a knowledge-driven and technology-intensive agriculture industry. The university also provides government and firms from across the globe with a wide range of research, professional training and consultancies. Some of the services provided by the university include the following:

- host of a number of research institutes that are undertaking leading research in the areas of: high quality and sustainable green living and crop management; live stock research; healthy food, fresh food chains and bio-based products; marine ecology; socioeconomic agriculture models and data analytics; food safety and detection; and greenhouse horticulture.
- provide industry access to a hub of researchers, laboratory and business development facilities, including developing software and apps for the industry.
- training covering a wide range of courses for undergraduate, postgraduate and doctoral students in the agriculture and agribusiness fields of study. The university also offers online courses, short courses, and professional training for industry and practitioners. The university also works very closely with major global food producers such as Heinz and Danone.
- The graduates trained by the university are readily employed by some of the best agriculture corporations in the world; and many are leading the development of the industry into becoming highly knowledge-intensive and tech-savvy.

For more information: http://www.wur.nl/en/

Best Practice: Case-Study 2.5 - Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTT) programs, United States of America Department of Agriculture.

The SBIR Program

The SBIR is a competitive program that provides small businesses in the US to undertake R&D activities that has a high potential of commercialisation. The goals of the program are four-fold:

- Encourage technological innovation in the agriculture areas;
- Undertake research and development in key priority areas that meet the needs of the industry;
- Nurture an inclusive innovation approach that encourages the participation of socially and economically disadvantaged communities to undertake innovation and entrepreneurship to create self-employment via sustainable business ventures and start-ups in the agriculture industry; and.
- Enhance firms in the agriculture industry to commercialize R&D and innovations funded by the government.

The funding is categorised into two phases and they are: Phase 1, USD$100,000 for a duration of 8 months; and, Phase 2, USD$600,00 for a duration of 24 months, for awardees who completed Phase 1 successfully. The grant applicants are strongly encouraged to include the participation of a university faculty or scientist from a GRI to strengthen the proposal. The project can also be led by a university professor or scientist from a GRI.

The key focus areas of funding include the following:

- ❑ Forests and Related Resources
- ❑ Plant Production and Protection – Biology
- ❑ Animal Production and Protection
- ❑ Air, Water and Soils
- ❑ Food Science and Nutrition
- ❑ Rural Development
- ❑ Aquaculture
- ❑ Biofuels and Bio-based Products
- ❑ Small and Mid-Size Farms
- ❑ Plant Production and Protection – Engineering

For more information: https://nifa.usda.gov/program/small-business-innovation-research-program-sbir

The STTR Program:

The STTR program is a publicly funded scheme to encourage R&D and innovation in key focus areas that are strategic to the development of the agriculture industry through a partnership model between industry, GRIs and universities. The goals of the program are to achieve the following:

- to enhance technological innovation in the agriculture areas;
- to foster technology transfer via a cooperative R&D engagement model between small businesses and research institutions; and,
- Increase commercialization of innovations from the government R&D funding.

There are three phases of funding under this scheme and they are: Phase 1 for projects with sound technical merit with high commercial potential and the total funding allocated is USD$150,000 for a duration of 12 months; Phase 2, projects that met Phase 1 KPIs and have sound scientific and technical merit and high commercial potential can apply for an additional funding of up to USD$1 million; Phase 3, where small businesses will undertake the commercialization activities without any funding; but the firms may get other incentives in the form of funding if the product or services are used by government agencies. In this context, government becomes one of the major users of the new innovations.

Funding under this program is undertaken via the National Science Foundation funding, where the following key priority areas within the agriculture areas are funded:

- Agricultural and Food Safety Biotechnology – in particular areas addressing (but are not limited to) drought tolerance, improved nutritional value, enhanced disease resistance, and higher yield, technologies that enhance biodiversity, produce less carbon dioxide, and use less water and fertilizer, prevention of foodborne illness, food tracking, hygiene, additives, and certification systems.
- Biosensors, life science tools, bioinstrumentation, synthetic biology & metabolic engineering applications, fermentation and cell culture technologies, computation biology and bioinformatics techniques, advance functional genomics, Internet of Things, cloud technology, big data and security systems that are widely used in the agriculture areas.

For more information: https://www.sbir.gov/about/about-sttr

Best Practice: Case-Study 2.6 – Fraunhofer Chile's Applied Research that meets the needs of the Agriculture Industry

The Fraunhofer philosophy was introduced in Chile to strengthen its agriculture sector to ensure its agriculture crops are globally competitive. The Fraunhofer Chile Research Foundation was established to foster close collaboration between research scientist from Chile and Germany with the objective of nurturing Chilean innovations that were relevant for the Chilean agriculture sector. More than 100 research scientists were employed to work closely with universities, GRIs and industry to work on focussed research areas that will benefit the local agriculture industry and open new revenue streams for the economy. The research teams were formed and leverage on state-of-the-art platforms in biotechnology, nano-technology and ICT to make important discoveries that benefit key agriculture produce such as grapes, peaches, tomatoes, potatoes, nuts and avocados.

A team of researchers from GRIs, universities and industry work in multidisciplinary teams to address some of the challenges of the industry. The research team consists of researchers focusing on the following areas: biotechnology and gene sequencing methods to improve crop yield, productivity and pest-resistant crops; advanced monitoring methods for pest control; smart agriculture and precision farming methods to improve agriculture processes; and develop new applications and product lines – spawning new downstream industries.

The Fraunhofer philosophy also opens new revenue streams in the form of providing the following services: strategic planning of agriculture industries; consultancies; market studies; development of new processes and technology for industry and the research community in the country; undertake compound analysis using advanced technology for industry and the research community in the country; develop new sensors, monitoring methods, Internet of Things (IoT) and other technology for the agriculture industry; develop new informatics and data analytic tools as part of the Smart Agriculture Management System – a service that could be provided to industry, government and the research community. The team also builds expertise to provide data analytics and data modelling services for industry.

For more information: http://www.fraunhofer.cl/en.html

Best Practice: Case-Study 2.7 - Agriculture and Food Laboratory (AFL), University of Guelph, Canada.

The AFL is not only a leading applied research centre in Canada; it is also a 'one-stop-centre' that provides the agriculture community in Canada (agrochemical, growers, food services industry, food processing industry, dairy, researchers from other universities and government agencies) a wide range of services related to compliance to global best practices (food safety and environmental standards).

The laboratory works closely in partnership with industry, government and other universities to provide industry and other stake-holders access to its state-of-the-art laboratories and technical capabilities. The facility has 150 experts in a wide range of fields in DNA analysis, microbiological testing, agrochemical testing, specialized microscopy, nutrient analysis, diagnostic analysis, and testing for drug residues, pesticides and allergens. Experts also assist with matters related to compliance with global best practices related to food safety and environment standards for the Canadian agriculture and agri-food industries.

For more information: http://www.guelphlabservices.com/AFL/

CHAPTER 3

KNOWLEDGE CONTENT OF THE MALAYSIAN PLANT CROPS INDUSTRY (NON-PALM OIL)

CHAPTER 3
Knowledge Content of the Malaysian Plant Crops Industry (non-Palm Oil)

3.0 Introduction

In this chapter, we study the knowledge ecosystem of the plant crops (excluding palm oil), which include rice, cocoa and vegetables. The crops are important contributors to the domestic economy. Rice, a major staple food of the country accounts for 2.1% of the GDP in 2015 and is expected to increase to 2.3% by 2020[1]. On the Self-Sufficiency Level, the industry can only meet 71.4% of the nation's needs[2]. The remaining demand is met through imported rice from neighbouring countries such as Thailand and Vietnam. The key challenge for the rice industry is to transform itself into a knowledge-intensive industry that is able to meet the needs of the domestic market and be an important export revenue earner for the country. To enhance its global competitiveness, the industry needs to become more knowledge-intensive. Higher adoption of new technology and knowledge systems will help the industry raise its yield and lower the cost of production.

The other crops included in this study are fresh fruits, vegetables, cocoa beans, copra, and spice. These crops are unable to meet the local demand. Hence, the government imports from other countries to meet the needs of the domestic market. This represents a major capital drain on the country and puts at risk food security of the country. To ensure that Malaysia is self-sufficient in meeting the demand of the domestic market for the above-mentioned crops, the industry must be able to attain better economies of scale and scope by transforming the industries to be more knowledge and technology intensive.

In this chapter, we assess the knowledge ecosystem of plantation crops (non-palm oil industry) using the MYKE-III knowledge ecosystem model for a sample of 86 firms operating in Malaysia. From the sample, 5 are large firms, 81 are micro-SMEs, 80 are local firms and 6 are foreign.

The chapter is organized as follows: In Section 3.1, a description of a knowledge ecosystem of crop plants in an advanced country is provided. In Section 3.2, we provide a description of the knowledge ecosystem for the Malaysian crop plants. In Section 3.3, the key strengths and gaps in the Malaysian palm oil knowledge ecosystem are discussed. In Section 3.4, key recommendations to improve the knowledge ecosystem of the Malaysian palm oil industry are provided, concluding in Section 3.5.

3.1 Knowledge Ecosystem in an Advanced Agriculture Economy

The knowledge ecosystem for the agriculture economy for an advanced country was described in Section 2.1, where the dynamic capability components were well supported by all the enablers. Institutions such as government agencies play an orchestrating role in ensuring that adequate funding is provided for education and training so as to guarantee the industry workers at adequate skills levels to be efficient, productive and globally competitive.

In many advanced agriculture economies, government, industry associations and education institutions work jointly to develop a strategic plan that maps out the short-term, mid-term and long-term plans, programs and implementation strategy to ensure the agriculture industry is constantly improving the quality of their products and services; and that they meet global best practices and standards. As part of the plan, the following are clearly articulated in the plan:

- Areas of strategic development and R&D priority areas are identified.
- Talent management strategy, where core competencies for all levels of jobs are clearly described. Careful planning is undertaken to ensure the types of training, educational program and 'quadruple-helix' engagements are provided to enrich the learning experience as well as ensure the training meets the needs of knowledge-intensive industry
- Appropriate funding is provided to university and GRIs to undertake research projects that will spearhead some of the leading innovations that will be used by industry to raise their market reach and competitiveness.
- Ensure that the leading research centres have access to state-of-the-art research facilities and leading experts to foster translational research outcomes that benefit the industry. In this context, a number of countries adopt the Fraunhofer approach to achieve targeted research outcomes for firms in the agriculture industry, which opens up new revenue streams for firms.
- Clear technology- and knowledge-transfer programs are put in place, supported by appropriate incentives (grants, infrastructure support and expertise) to ensure industry benefits from the knowledge spill over.
- Increasingly, a number of countries have adopted Industry4.0, which provides seamless integrated services within the industry and across complementing industries for the farming community, thus improving their productivity and operational efficiency.

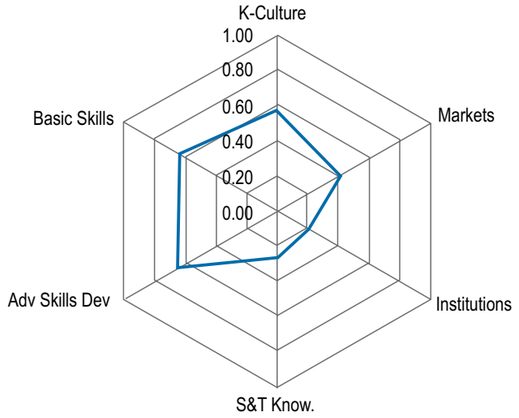
3.2 Knowledge Ecosystem of the Plant Crop (Non-palm Oil) Industry

A brief description of the knowledge ecosystem for the Malaysian plant crop (non-palm oil) industry is provided in this section of the report. Figure 3.1 shows the state of development of the knowledge enablers for the industry which indicates that the role of institutions in enhancing knowledge content, S&T

[1] Source: Economic Planning Unit (2015), Strategy Paper 20, Prime Minister's Department, http://rmk11.epu.gov.my/pdf/strategy-paper/.

[2] Source: Economic Planning Unit (2015), Strategy Paper 20, Prime Minister's Department, http://rmk11.epu.gov.my/pdf/strategy-paper/

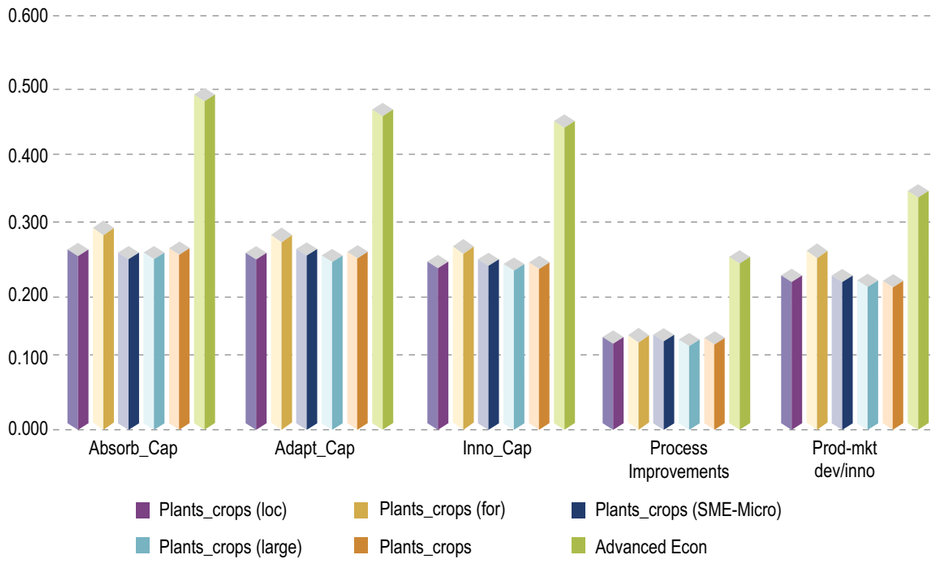
Figure 3.1: Knowledge Enablers for the Plant Crop (Non-palm Oil) Industry



knowledge use and access to market intelligence are limited – all three scored 0.4 or below. Access to basic and advanced skills and knowledge culture obtained moderate scores between 0.5 and 0.7. This suggests that the knowledge enablers for this industry are not operating at its full potential.

Figure 3.2 shows the dynamic capability components, process improvement and product development of firms in the plant crop industry. The dynamic capability components, process improvement and product development were measured for large firms, SMEs, local and foreign firms. Similar to the palm oil industry, the dynamic capability for Malaysian plant crops industry were found to be significantly lower than that of more advanced countries. Within the local industry, larger firms had higher absorptive, adaptive and innovative capabilities, resulting in higher process improvements. However, the product development for larger firms remains the same as the micro-SMEs in the industry. In terms of foreign versus local firms, Figure 3.2 shows that foreign firms have higher absorptive, adaptive and innovative capabilities than local firms. The process improvements for foreign firms were found to be higher. However, the product development was similar for both foreign and local firms.

Figure 3.2: State of the Dynamic Capabilities of the Plant Crop (Non-palm Oil) Industry

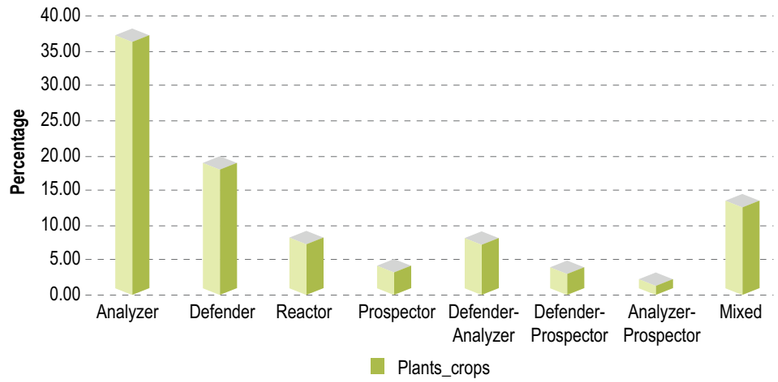


Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

In terms of the strategic postures of firms, Figure 3.3 shows that a majority of the firms in the industry are Analyser (over 37%) and Defender (over 20%) firms. Only 3% of the plant crop firms are classified as Prospector firms, which are highly innovative firms.

The knowledge ecosystem for the plant crop industry is shown in Figure 3.4. The knowledge ecosystem around the plant crop was found to be weaker than that of ecosystems around plant crops from more advanced countries. The figure shows that institutions in the plant crop industry play a key role in developing the knowledge enablers. However, it only has a moderate impact on innovative capability and not absorptive and adaptive capabilities. The other knowledge enabler that impacts the dynamic capability components is S&T knowledge and it has a positive yet moderate impact on adaptive capability. One of the interesting results that emerged from the analysis is that market intelligence has a negative and moderate impact on adaptive capability. This result is not surprising as most of the farming communities in Malaysia are dependent on government agencies for market information. In most instances, government agencies may not be at the forefront of changes and trends that are taking place in national, regional and global market.

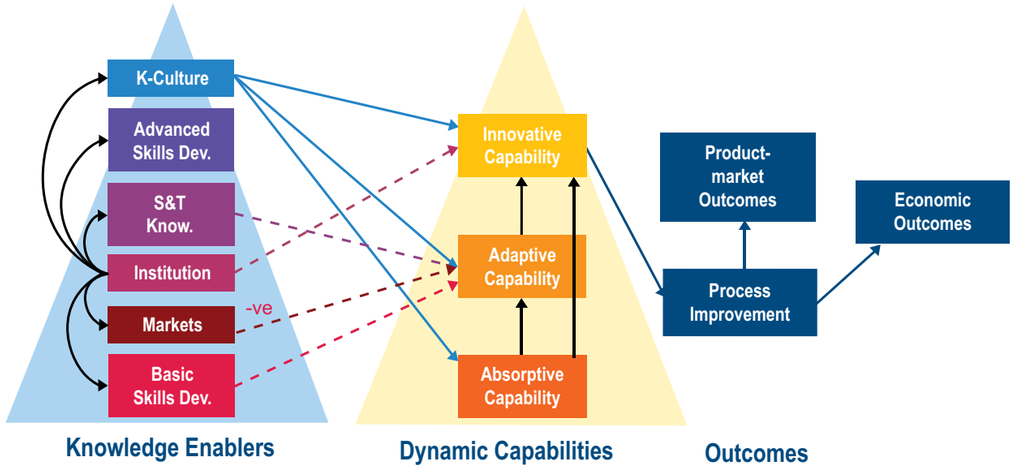
Figure 3.3: Strategic Posture of the Firms in the Malaysian Plant Crop (Non-Palm Oil) Industry



The model also shows that some firms try to 'leap-frog' from acquiring absorptive capability to innovative capability, without first building adaptive capability. This provides firms some short-term advantages, but often these innovations are not sustainable in the longer term. There are also considerable number of firms that build their adaptive capability before undertaking more innovative endeavours.

The empirical analysis also shows that many innovations undertaken by the firms result in process improvements, which contribute to some product market outcomes. However, much of the economic outcomes from this industry are derived from process improvements. That is, firms building their capability to use new technology and knowledge to produce products and services that are more cost-effective than those of their competitors. This is a source of competitive advantage in the domestic market.

Figure 3.4: Knowledge Ecosystem of the Plant Crop (Non-palm Oil) Industry



3.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Plant Crop (Non-palm Oil) Industry

Based on the analysis of the knowledge ecosystem of the plant crop (non-palm oil), the key strengths and gaps of the ecosystem are provided in this section of the report.

Key Strengths of the Plant Crop (Non-palm Oil) Ecosystem:

- Malaysia has a tropical climate that supports a wide range of plant crops.
- The plant crop industry receives significant support from the Malaysian government to transform itself into a technology-intensive and competitive industry through various land development initiatives.
- Malaysia has a number of universities that undertake R&D activities in the plant crops industry.
- There are a number of local players that are large and some of them undertake R&D activities to enhance the quality and quantity of products and services.
- The plant crop industry is an important source of employment for rural communities in Malaysia.
- The cost of labour in the rural areas and the use of foreign labour have kept the cost of production in the plant crop industry low and regionally competitive.

Key Gaps Plant Crop (Non-palm Oil) Knowledge Ecosystem:

- While the industry has a strategic plan for agriculture, the plan has not been updated regularly to keep pace with rapid changes taking place in the industry. Fore-sighting and sign-posting of future directions of the industry and the role of new technology (biotechnology, nano-technology, Internet of Things (IoTs) and other technologies) and converging technological landscape has not been given adequate focus in the plans.
- There are also too many institutions with overlapping roles managing the plant crop industry, which increases bureaucracy. The problem is further exacerbated with the lack of updated online resources of the institutions managing the plant crops industry. A lack of a 'one-stop-portal' or 'service centre', where the farming community can gain access to information, services, expertise and other support, hinders the industry from building knowledge capability and content.
- Institutions such as government agencies and trade associations do not have lead S&T staff or expertise in global best practices and standards. Hence they are unable to directly influence the dynamic capability components.
- Firms in this industry, with the exception of large firms, do not invest adequate resources in technology, systems and capability development that enable them to access important market intelligence for strategic decision making. This is attributed to their over-reliance on government agencies and suppliers of services for market information. Government agencies may not have the right skill set to assess market trends and suppliers tend to "lock-in" firms to due to their vested interest; all of which hinder adaptive and innovative capabilities.
- Firms in the industry do not invest in capability development programs for unskilled workers, as they have access to cheap unskilled transient workforce from neighbouring countries. Hence, the industry remains labour intensive and is unable to compete with countries with larger labour pools and better technology.
- Most large and foreign firms invest in attracting skilled work force, hence their dynamic capability components are higher than smaller and local firms. Key factors impacting local micro-SMEs are the inability to attract talent due to uncompetitive remuneration, a lack of career prospects and low levels of opportunities to upgrade their skillset. Firms are not willing to spend time and effort to train staff due to high 'talent-poaching' in the industry.
- Inability of the firms (especially among local micro-SMEs) in hiring skilled work force with sound technical and managerial knowledge hinders the firms from adopting new technology and industrial approaches (such Industry 4.0 systems) to raise the adaptive and innovative capabilities of the firms.
- There is a serious shortage of students enrolling in science and technical courses in universities and this has had an adverse impact on industries such as plant crops. Low levels of enrolment in S&T related areas impact the ecosystem negatively in firms not being able to employ adequately qualified staff that can undertake adaptive and innovative capabilities. This impacts the ability of the local industry from generating incremental and radical innovations alike that will lead to both process innovation and new product development.
- While the Malaysian government has allocated significant resources for R&D activities in the plant crops industry, there are challenges in the flow-through of the R&D activities to industry. Among the key challenges include the inability of translating academic research into real-world practical outcomes and a disconnect between academia and industry, when academia does not meet the needs of industry due to a weak partnership model.
- Firms, especially SMEs, also do not invest adequate resources in advanced skills development such as developing systems and processes for meeting global best practice and standard (quality control expertise), technical services (sequencing, DNA analysis, bio-informatics, big data analytic others), marketing, branding and positioning their products and services. Furthermore, there are very few service providers within the ecosystem that are able to provide such services for the plant crop industry. Even if these services are available, micro-SMEs are unable to afford such services. Larger and foreign firms are in a better position to acquire such services; hence have higher levels of absorptive, adaptive and innovative capabilities than local and micro-SME firms.
- The culture of knowledge sharing among ministries and industry is not as pervasive as compared to that in more advanced countries. Due to the lack of knowledge sharing and scarcity of online information forums, most micro-SMEs rely on the government and their technology partners for knowledge and information. Given the competitive nature of the industry, firms may not get up-to-date information on a wide range of issues that would help enhance their knowledge content and elevate them to a more strategic position in the domestic and global markets.

3.4 Recommendations to Improve the Malaysian Plan Plant Crop (Non-palm Oil) Ecosystem

The plant crop industry is strategic to the development of a number of industries including the rubber & plastics and the food-processing industry. The industry is also critical for ensuring the food security of the country. To raise the knowledge content and competitiveness of the industry, the following recommendations are proposed.

Recommendation 3.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Plant Crop (Non-palm Oil) Industry

- Competitiveness of the industry is a function of the industry being able to meet the global best practices and benchmark standards in food safety, nutrition, healthcare, and environment. In most advanced countries, where agriculture is an important revenue generator, substantial resources are channelled to develop an ecosystem that not only meets global standards but become a standard setter.

- It is proposed that the investments be channelled to develop the talent, infrastructure and other support systems to develop capabilities in the plant crop industry that are able to meet global standards and best practices. These include that ensuring government officers and trade associations have sound knowledge on the global best practice and benchmark standards so that they are able to provide assistance to firms to achieve these standards.

- Transparent systems and online forums must be in place to disseminate information on firms adhering to best practices and benchmark standards. The portals should be user-friendly and are continuously updated.

Best Practice: ***Case-Study 2.1 - Food Standards Australia-New Zealand***

Recommendation 3.2: Enhance the Knowledge Institutional System of the Plant Crop industry

- Government should play an orchestrating role to establish sound institutional set-ups to foster close collaboration between key government agencies, industry associations and institutions of learning to formulate a clear plan for the plant crops industry to build knowledge content and global competitiveness.

- Establish a clear direction for the development of the plant crop industry by developing a strategic plan that maps the key R&D focus areas of development. The plan should provide a short-term, medium term and long-term plan to transform the industry into a knowledge intensive industry.

- The plan should have a clear implementation strategy to meet the established key performance indicators and milestones. It is also ensured that micro-SMEs have access to the necessary resources, support services, technology and networks to be able to increase their knowledge content and market reach.

Best Practice: ***Case-Study 2.2 - Growing Forward 2 (2013-2018): A 5 year Federal-Provincial-Territorial initiative***

Recommendation 3.3: Develop the Knowledge Capital of the Plant Crop Industry

- Appreciation for nature and agriculture industry must commence in early education. For agriculture education to be taken seriously, it has to be a core subject in the main public examinations up to SPM.

- To create highly motivated farmers, adequate training for farmers to professionalise their work in a more economical, ecologically sound and socially responsible way should be available in the various localities and online learning platforms.

- To raise the level of knowledge intensity of the workforce, opportunities should be given to workers without formal qualifications to enrol in institutes, colleges and polytechnics to gain professional certification in an agriculture related area.

- These training programs should be 'hands-on' with industry placement and internship at the core of the course/training curriculum.

- The training program should also clearly map a career pathway for students to enrol in higher level technical and academic qualifications.

Case Study 3.1: Education and Extension Program (Farmer Education) by National Institute of Food and Agriculture, USA Department of Agriculture

Recommendation 3.4: Develop the Knowledge Competency for the Plant Crop Industry

- The industry should focus on developing core competencies in the plant crops industry such as rice, cocoa, vegetable, spices and others. This includes adopting, adapting and generating new knowledge on innovative farming methods, technology, management systems, financial models and other skills sets to ensure sustainable management plant crop firms.

- It is important to continue to provide support for the various agriculture based CoEs (GRIs and universities) to develop new scientific discoveries, technology and expertise to ensure high yield crops, more efficient and environmentally friendly farm management practice, adoption of systems and processes that enhance operational efficiency of the firms, and ensure they adopt an Industry4.0 framework.

- The CoEs work closely with educational institutions and training institutes to translate the new discoveries into programs that can be implemented by the farming community

Best Practice: ***Case-Study 2.4 - Wegeningen University, World's Number 1 University for Agriculture Education***

Recommendation 3.5: Facilitate Knowledge Learning & Transfer within the Plant Crop Industry

- Financial support in the form of grant (industry-linkage grant), infrastructure support and other development investments are given to universities and GRIs to assist local plantation firms to acquire the necessary R&D support, expertise and other development support to transform their businesses into knowledge-intensive firms.

- ❑ Key KPIs of public institutions should be aligned to support the development of local firms, especially micro and SMEs to undertake R&D activities, providing them with access to testing and sequencing facilities and specialized expertise that would help them build their dynamic capabilities to enhance process improvements and new product development.

Best Practice: ***Case-Study 2.5 - Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTT) programs, United States of America Department of Agriculture.***

Recommendation 3.6: Incorporate an Innovative Knowledge Approach within the Plant Crop Industry

- ❑ One of the ways to intensify knowledge content in the plant crop industry is to adopt the Fraunhofer philosophy, which fosters strong partnerships between industry, GRIs, and universities to undertake translational and applied research.

- ❑ The key focus areas should be:
  - ■ Use of advanced technology (ICT, gene-sequencing methods, nanotechnology and biotechnology) to generate high yield crops that are pest-resistance.

  - ■ Develop state-of-the art technologies to design and develop sustainable and eco-friendly farming practices.

  - ■ Develop smart agriculture technology and precision farming methods for the local crops, which will reduce cost and improve operational efficiency.
  - ■ Identify key bioactive compounds that will scientifically lead to a wider range of applications of the crops and spawn new downstream industries.

  - ■ Development of new technology, informatics tools and knowledge management systems that benefit plantations in the tropical environment.

  - ■ Target outcomes to be achieved in higher levels of process improvement and product development via technology/knowledge transfer, IPs, commercialisation of IPs/ patents, management services, workshops trainings and consultancy.

Best Practice: ***Case-Study 2.6 – Fraunhofer Chile's Applied Research that meets the needs of the Agriculture industry***

Recommendation 3.7: Strengthen the Knowledge Leverage within the Plant Crop Industry

- ❑ GRIs such as MARDI, RRI, SIRIM and other related agencies should be important 'One-Stop Centre' for the farming community in Malaysia. The digital portal should contain up-to-date information on a range of information on new discoveries, technology, global trends and leading researchers in Malaysia and market intelligence. The portal should be an important source of information and knowledge for firms in the industry.

- ❑ Similar to the palm industry, the universities, colleges, polytechnics and training institutes can be knowledge centres for the various firms across the country.

Best Practice: ***Case-Study 2.7 - Agriculture and Food Laboratory, University of Guelph, Canada.***

3.5 Conclusion

This chapter provided insights in the key strengths and gaps in the knowledge ecosystem for the Malaysian plant crop industry. The study shows that the knowledge ecosystem for the plant crops for Malaysia is relatively weaker than that of the palm-oil industry and agriculture industries in more advanced countries. The latter is more technology and knowledge intensive, while most of the Malaysian plant crop industry remains labour and low tech industry. Key policies and strategies to strengthen the knowledge enablers were discussed in this chapter, which will raise the dynamic capability of firms in the plant crop industry. This enables the firms to enhance their process improvement and generate higher levels of product development. This will also strengthen the competitiveness of the industry both in the region and globally.

Appendix for Chapter 3

Best Practice 3.1: Education and Extension Program (Farmer Education) by National Institute of Food and Agriculture, USA Department of Agriculture

To ensure that farmers in the USA cope with the complex challenges of agriculture communities in the 21st Century (due to a more competitive global market; high environmental and food safety standards; and the emergence of new scientific and technological advancement), the USA Government has introduced a number of capability development and education extension programs for the farming community to keep pace with the developments and enhance their competitive position globally. Among the programs include the following:

- continuous upgrading of the skills and training of the farming community by providing grants, scholarships and fellowships to upgrade their knowledge and science and technology base to transform their firms into more knowledge intensive and competitive players in the industry;

- increase research, teaching and extension programs in underserved areas and marginalised agriculture communities so as to enable them to develop creative solutions and innovations to overcome some of the challenges encountered by these farming communities;

- foster learning and engagement of youth in secondary and post-secondary institutions with food and agriculture related education and industrial development so as to encourage them to choose farming as a preferred career choice;

- provide extension programs for farmers to incorporate latest scientific knowledge and technology in the daily operations that lead to the following:
  - ❑ practices that are less harmful to the environment;

  - ❑ reduce food contamination;

  - ❑ reduce the use of water and chemicals for the crops;

  - ❑ incorporate system, processes and technology that reduce operational cost, increase yield and profitability;

- introduce programs that help farmers to achieve the following:
  - ❑ manage their firms efficiently, make sound financial decisions and seek new economic opportunities and revenue streams;

  - ❑ use the best scientific knowledge and technology to get a better return on their investment in land, water and ecosystems;

  - ❑ have a good understanding of the implications that public policies and global standards have on the operations of the firms;

  - ❑ have sound knowledge of new tools, technologies and industrial practices (Industry4.0, standards and best practices)

  - ❑ to enhance operational efficiency and value proposition of their products and services; and,

  - ❑ use new scientific discoveries and technological innovations to improve the production, marketing, branding and positioning of the products and services.

Source:
United States Department of Agriculture. (2016). *Farmer Education*. Retrieved from https://nifa.usda.gov/topic/farmer-education

CHAPTER 4

KNOWLEDGE CONTENT OF THE MALAYSIAN FORESTRY INDUSTRY

CHAPTER 4
Knowledge Content of the Malaysian Forestry Industry

4.0 Introduction

The knowledge ecosystem of the forestry industry is examined in this chapter. The forestry industry contributes close to RM7.12 billion to the Malaysian economy, or 6.1% of the GDP in 2015.[3] The forestry industry is an important source of wealth and employment for East Malaysia. To ensure that there is a steady stream of the supply of timber for several downstream wood-based industries, the Malaysian Government encouraged large scale commercial plantation. These commercial plantations enabled the industry to be sustainable without depleting the native forest reserves of the country.

In March 2005, the Ministry of Plantation Industries and Commodities (MPIC) was mandated to lead the development of forest plantations in Malaysia. This has led to the development of 375,000 hectares of forest plantation, where the annual planting rate of 25,000 hectares per year was put in place for the next 15 years. It is envisaged that if the program is implemented effectively, every 25,000 hectares of land planted will yield 5 million cubic meters of timber[4].

[3] Economic Planning Unit. (2015). Strategy Paper 20, Prime Minister's Department. Retrieved from http://rmk11.epu.gov.my/pdf/strategy-paper/.

[4] Malaysian Timber Industry Board. (2016). Home. Retrieved from http://www.mtib.gov.my/

Over the last decade, the forestry came under a lot of threat due to cheaper forestry products from neighbouring countries in the ASEAN region, and the increasing pressure from environmental movements across the globe banning the use of timber and wood-based products from the natural rainforest. To ensure the industry remains relevant and competitive, the forestry industry will be required to re-examine its model of development; and ensure that the forest plantations are able to extract the maximum value for the existing yield of forest related timber and wood-based products.

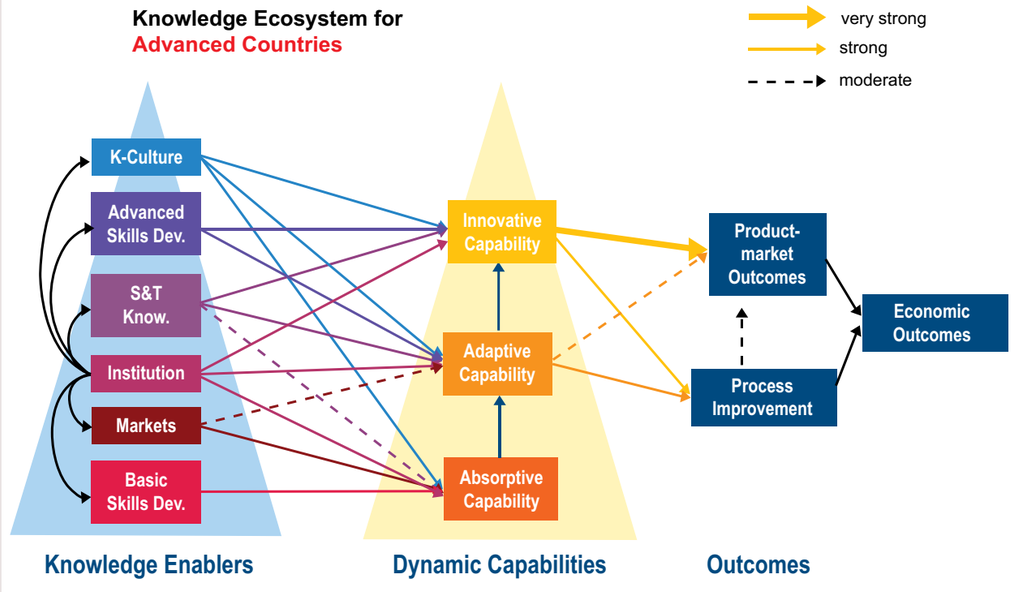
In this chapter, we assess the knowledge ecosystems of the forestry industry using the MYKE-III knowledge ecosystem model for a sample of 97 firms operating in Malaysia. From the sample, 20 are large firms, 77 are micro-SMEs, 93 local and 4 foreign firms. The forestry industry consists of the following sub-industries: Silviculture and other related activities; logging; gathering of non-wood products; and, support services for the forestry industry.

The chapter is organized as follows: In Section 4.1, a description of a knowledge ecosystem of the forestry in an advanced country is provided. In Section 4.2, we study a description of the knowledge ecosystem for the Malaysian crop plants. In Section 4.3, the key strengths and gaps in the Malaysian forestry ecosystem are discussed. In Section 4.4, key recommendations to improve the knowledge ecosystem of the Malaysian forestry industry are provided, before concluding in Section 4.5.

4.1 Knowledge Ecosystem for the Forestry Industry in an Advanced Country

The knowledge ecosystem of the forestry industry capturing the intricate relationships between knowledge enablers, dynamic capabilities and economic outcomes is shown in Figure 4.1. The figure shows the forestry industry in advanced economies to be constituted by rich interlinks between knowledge enablers, dynamic capabilities and outcomes. Knowledge enablers of the forestry industry ecosystem are strong and play a key role in the nurturing and development of strength in all three components of dynamic capabilities. Firms possessing strong capabilities leverage upon this position of strength to create a high level of positive

Figure 4.1: Complex Relationships in the Forestry Industry in an Advanced Country



outcomes through process improvements and new product developments. Both of these combine to contribute to economic outcomes.

The knowledge ecosystem for the forestry industry in an advanced country exhibits high level of development and positive contribution to the economy. To ensure the industry remains sustainable, significant resources are invested to continuously enhance its dynamic capability. Hence, the knowledge enablers for the forestry industry in advanced countries are able to contribute to the absorptive, adaptive and innovative capabilities which drive process improvement and product development. All of these combine to enhance economic outcomes. In these countries, the following have been undertaken by the forestry industry shown in Figure 4.1:

- *Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Plant crop (non-palm oil) Industry* – put in place a robust certification process to ensure the industry meets the global sustainability practice.

- *Enhance the Knowledge Institutional System of the Plant Crop Industry* – government in partnership with the firms formulate a plan to develop an institutional set-up to draft a vision and plan for the industry, identify key priority areas of development, with a clear implementation strategy in place.

- *Develop the Knowledge Capital of the Forestry Industry* – professionalise the work force by having a wide range of training programs and courses from non-award certification training programs to more formal qualifications such as diploma, undergraduate, postgraduate and research programs.

- *Develop the Knowledge Competency for the Forestry Industry* – clearly map out the skill set needed by the industry and have a systematic framework for tracking the changing landscape of the industry and instituting a review process and upgrading of the competencies.

- *Facilitate Knowledge Learning & Transfer within the Plant Crop Industry* – a sound integrated framework is in place in most advanced countries to develop the key priority areas through S&T and R&D and ensure that the spill-over benefits are translated for industry.

- I*ncorporate an Innovative Knowledge Approach within the Forestry Industry* – use of advanced technology to foster seamless integration of all production processes within the forestry value chain from ensuring translation R&D outcomes, improving operational efficiencies, developing new products and support services, and creating new revenue streams from the new lines of products and support services.

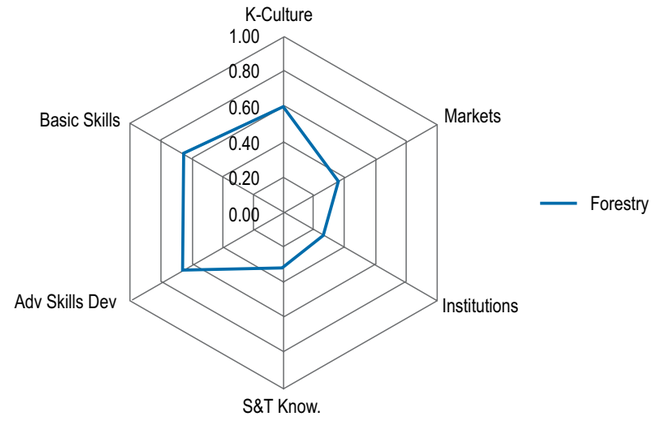
- The Ecosystem has very Strong Knowledge Leverage within the Forestry Industry – institutions (government agencies, industry association and educational institutions) play a key role in establishing platforms and forums of exchange of information and knowledge to firms in the industry.

Example of best practices of the above is given in ***Case-Study 4.1: A New European Union Forest Strategy for Forest and Forest-Based Sector.***

4.2 Knowledge Ecosystem of the Malaysian Forestry Industry

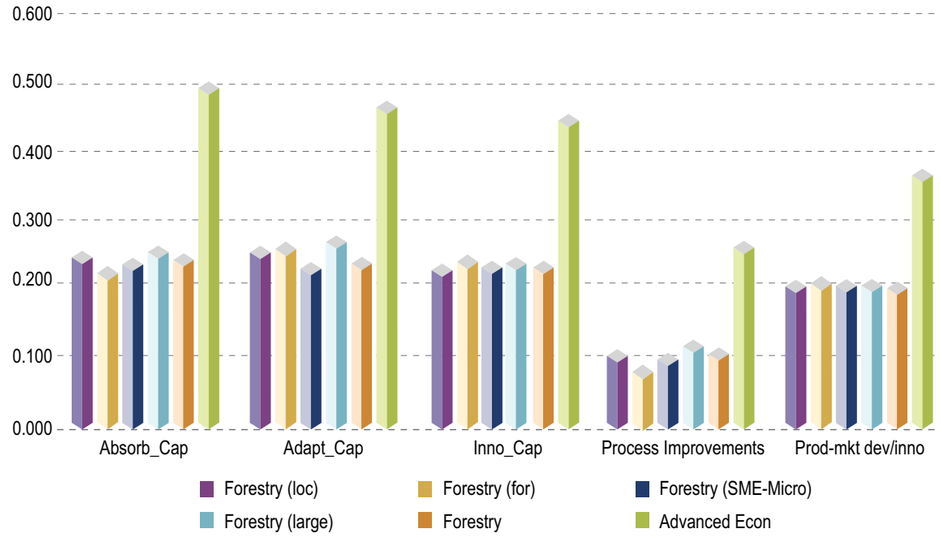
A brief description of the knowledge ecosystem for the Malaysian forestry industry is discussed in this section. Figure 4.2 shows the state of development of the knowledge enablers. Three of the knowledge enablers (institutions, market intelligence and S&T knowledge) are performing below optimal level (below 0.5); while three of enablers (basic skills, advanced skills and k-culture) are performing at the moderate level, above 0.5.

Figure 4.2: Knowledge Enablers for the Forestry Industry



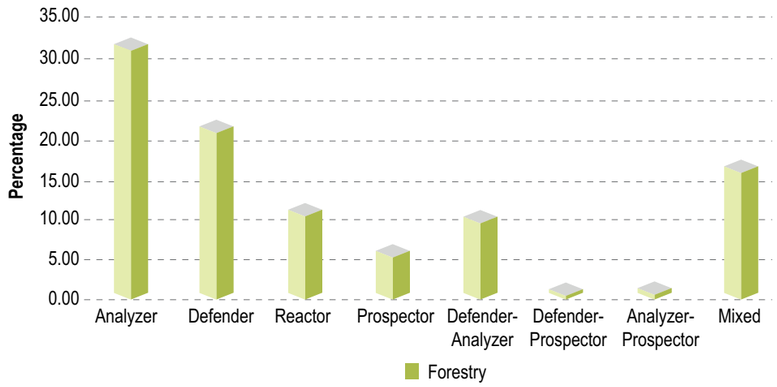
The state of development of the dynamic capability components, process improvement and product development for the Malaysian forestry industry is shown in Figure 4.3. The dynamic capability, process improvement and product development for advanced countries were found to be significantly higher than that of the Malaysian forestry industry. Within the Malaysian palm oil industry, foreign firms were found to have slightly higher absorptive capability than foreign firms. The adaptive capabilities of local and foreign firms were found to the same. Foreign firms had slightly higher innovative capability. Larger firms were found to have higher absorptive, adaptive and innovative capabilities than micro-SMEs. In terms of process improvement, the score for local firms were higher than foreign firms. However, foreign firms have a slightly higher product market development than local firms. Larger firms were found to have slightly higher process improvement and product market development.

Figure 4.3: State of the Dynamic Capabilities of the Forestry Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

Figure 4.4: Strategic Posture of the Firms in the Malaysian Forestry Industry

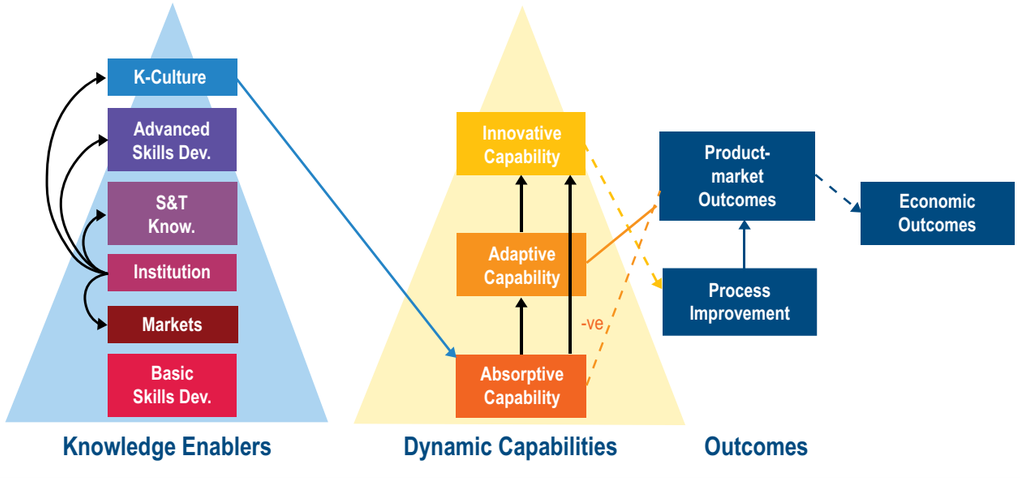


The strategic postures of firms in the Malaysian forestry industry are given in Figure 4.4. The figure shows that the percentage of firms based on their strategic posture are as follows: Analyser firms is 32%; Defender, 22%; Reactor, 11%; and, Defender-Analyser, 12%. Around 6% are Prospector firms in the forestry industry. A significant percentage of the firms adopt a mixed strategic posture, 16%. The analysis suggests that a small percentage of firms (Prospectors) invest in innovative and creative endeavours as their competitive strategy.

The knowledge ecosystem for the forestry industry is given in Figure 4.5. Institutions in the ecosystem were found to have a significant positive impact on all the other knowledge enablers with the exception of basic skills development. None of the knowledge enablers were found to impact the dynamic capability components, with the exception of k-culture. K-culture was found to have a positive impact on absorptive capability. As firms build their absorptive capability, they develop their adaptive and innovative capabilities. The analysis also shows that there are a segment of the firms in the forestry industry that try to 'leap-frog' from absorptive to innovative capability.

In this industry, some firms that have a strong absorptive capability tend to try to introduce new products to the market. However, many of the products are of inferior quality due to a lack of sophistication.

Figure 4.5: Knowledge Ecosystem of the Forestry Industry



This has a negative impact on the product market outcomes. The industry also shows that firms with strong adaptive capability have a significant impact on product market development. Firms in this industry that have strong innovative capability tend to improve their production processes. This leads to new product development, resulting in positive economic outcomes. The empirical analysis suggests that the ecosystem is relatively weaker than in more advanced countries. However, a small segment of the firms in the industry are innovators (Prospector firms) that improve their production processes and introduce new products to the market.

4.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Forestry Industry

Based on the analysis of the knowledge ecosystem of the forestry, the key strengths and gaps of the ecosystem are provided below.

Key Strengths of the Forestry Ecosystem:

- Strong support from the Malaysian government to develop the industry, where a total of RM440 million government loans will be given and another RM1.2 billion government loans was set aside for firms interested in establishing forest plantations (Malaysian Timber Council, 2016a)

- The tropical climate and environment are suitable for the cultivation of the following trees that are in high demand by downstream industries: Rubberwood (Hevea brasiliensis), Acacia mangium, Teak (Tectona grandis); Sentang (Azadirachta excelsa); Khaya (Khaya ivorensis/ Khaya senegalensis); Kelempayan/Laran (Neolamarckia cadamba); Batai (Paraserianthes falcataria); Binuang (Octomeles sumatrana); and Eucalyptus.

Key Gaps Forestry Industry Ecosystem:

- The industry is labour intensive and uses cheap and transient labour from neighbouring countries. Hence, it spends limited resources on basic skills development. There is also no urgency to make the industry more knowledge and technology intensive.

- The institutions are not directly influencing the dynamic capability components because the institutions lack the experts with strong S&T skills to train and enable the industry to move up the innovation value chain.

- Firms are risk-averse when investing in technology and R&D to improve the quality of the trees, replanting, harvesting methods and new industrial approaches, knowledge management systems and processes.

- Firms in this industry have difficulty in attracting talent due to uncompetitive remuneration, poor working conditions (3D jobs), training opportunities and career prospects.

- The industry generally is not tech-savvy and lacks skilled workers and talent. Hence, the firms do not use technology to gain market insights and intelligence to improve their decision making processes. Many firms tend to rely on suppliers or intermediaries for technology, information and knowledge which can hinder their own innovative capacity.

- Access to technical education and training related to the forestry is scarce and expensive. Hence, firms, especially micro-SMEs, are unable to keep abreast of scientific and technological changes and new discoveries taking place in the industry.

- The level of R&D investment in the industry is low and most R&D undertaken by local institutions is not relevant or does not meet the needs of the industry.

- Weak collaboration and cooperation between universities, GRIs and firms renders suboptimal outcomes for all these stakeholders. Funds are wasted on R&D activities that are not relevant to the industry, and the firms do not get the necessary discoveries that can potentially enhance their knowledge content and competitiveness. Furthermore, the knowledge sharing culture among firms in the industry is very weak.

- Firms are not aware of all the services provided by government agencies and a “one-stop centre” does not exist, where the workers in the forestry industry can easily access services on market information, R&D opportunities and other business development services.

4.4 Recommendations to Improve the Malaysian Forestry Ecosystem

The forestry is an important industry for the economy of Malaysia, especially in states such as Sabah, Sarawak and Pahang. Competition from neighbouring countries such as Myanmar, Indonesia and Thailand with forest reserves, whose larger labour pools signify major competition for the Malaysian forestry industry. To ensure the industry continues to be sustainable and to provide higher employment and more competitive remuneration benefits, it will require a more strategic approach to strengthening the knowledge ecosystem and knowledge content of the forestry industry.

Recommendation 4.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) within the Forestry Industry

- Increasingly, the forestry industry is under scrutiny due to its adverse impact on global warming and other environmental problems. Improving technology and traceability of forest products are forcing industries across the globe to adhere to global best practices in sustainable forest management. It is an important source of competitive advantage and non-tariff barriers for many developing countries such as Malaysia.

- To meet the increasing global demand for certified wood and forestry products, the local forestry industry should continue to invest in developing and raising awareness among firms on the Malaysian Timber Certification Scheme (MTCS) process on the Certificate for Forest Management and Certificate of Chain of Custody, which is endorsed by Programme for the Endorsement of Forest Certification (PECF), an international accreditation body. Only 32% of the permanent reserve forest are PECF certified and 250 firms have obtained the MTCS chain of custody certification[5].

- The standards must be underpinned by sound and the latest scientific evidence and technological developments.

- Significant resources must be channelled into the development of talent, technology, monitoring and surveillance to ensure adherence to global best practices. While regulations for illegal logging and non-conformance are in place, education and enforcement needs to be intensified.

Best Practice 4.1 from ***Case-Study - A New European Union Forest Strategy for Forest and Forest-Based Sector.***

Recommendation 4.2: Enhance the Knowledge Institutional System of the Forestry Industry

- The forestry industry is an important contributor to Malaysia’s bio-economy. To ensure the industry plays a key role in the nation’s bio-economy agenda, key institutions (government agencies, industry associations, and universities) should work closely to develop a strategic plan that ensures the forestry industry is developed in a sustainable way. This would require strong leadership in achieving the following:

  - Providing innovative products and solutions to society through the adoption of Industry4.0-type framework and Fraunhofer philosophy.

  - Adherence to global environmental best practices and standards so as to ensure the industry manages its forest resources in a sustainable way.

  - Ensuring preservation and conservation of the natural forest for future generation – important spill-over impact on other industries such as tourism, healthcare, and pharmaceuticals.

Best Practice 4.2 from ***Case-Study - A New European Union Forest Strategy for Forest and Forest-Based Sector.***

Recommendation 4.3: Develop the Knowledge Capital of the Forestry Industry

- Dedicated R&D funding should be allocated under the Science & Technology and Innovation (MOSTI) grant scheme, Ministry of Higher Education research funding schemes (Fundamental Research Grant and Long-Term Research Grant) and national funding channelled for the establishment for Higher Institution Centre of Excellence (HICoE) in the Forestry and related industries.

- Industry PhD and research programs should be intensified and key institutions (government agencies, industry associations and universities) should have a plan to increase the number of research personnel in the industry. These programs should enable students to undertake their research work, with co-supervision from leading industry experts using some of the state-of-the-art industry research facilities.

- The long term sustainability of the forest industry will be dependent on the ability of the workers to use modern technology, manage knowledge systems and environmentally sound practices. To professionalise the workforce, opportunities should be given to workers in the forestry industry to undertake courses and training to be certified professionally via local institutes, colleges or polytechnics. The programs should also be affordable and flexible, catering to working adults. The training programs offered via the colleges and polytechnics must have a strong internship component with industry players.

- To nurture talent in the industry, a clear pathway must exist for some students and workers to transition from certificate to higher level qualification.

Best Practice 4.3 from ***Case-Study - A New European Union Forest Strategy for Forest and Forest-Based Sector.***

Recommendation 4.4: Develop the Knowledge Competency of the Forestry Industry

- To professionalise the workforce, training and education must develop core competencies in the following critical areas:
  - Forest cultivation and management;
  - Harvesting and haulage;
  - Sawmill and processing of the timber;
  - Manufacturing timber products;
  - Trading and merchandising timber;
  - Environmental best practices; and,
  - Use of advanced technology for improving operational efficiencies.

- The course and training must incorporate the Industry 4.0 framework that enables firms to utilise multiple technology platforms to seamlessly integrate production, harvesting, manufacturing, promotion and marketing value chains simultaneously. These do not only increase operational efficiency, but also plan, refine and implement strategies and programs to mitigate uncertainties and future-proof the industry.

Best Practice 4.4 from ***Case-Study - A New European Union Forest Strategy for Forest and Forest-Based Sector.***

[5]Source from Malaysian Timber Council. (2016b). Malaysian Timber Certification Scheme (MTCS). Retrieved from http://mtc.com.my/malaysian-timber-certification-scheme

Recommendation 4.5: Facilitate Knowledge Learning & Transfer within the Forestry Industry

- Incentives should be given to strengthen collaborations between industry, community organization, NGOs, GRIs and universities through an optimal funding model (leading to a win-win outcome for all parties). In this context, universities and GRI are funded by federal and state governments to undertake R&D activities in key focus areas that will assist the forestry industry in transitioning to a knowledge intensive and competitive industry. The funding is provided for assisting firms, especially SMEs, gain access to research infrastructure, expertise and other business development services.

- GRIs and universities are rewarded in terms of the quantum of funding and other support based on the track record in supporting the firms in the forestry industry to enhance their knowledge content.

- Firms that invest in R&D and staff development are given tax deductions and access to large research support via the approved universities and GRIs.

Best Practice 4.5 from ***Case-Study - A New European Union Forest Strategy for Forest and Forest-Based Sector.***

Recommendation 4.6: Incorporate an Innovative Knowledge Approach within the Forestry Industry

- Intensify knowledge sharing among all stakeholders in the forestry industry by adopting the "Fraunhofer" philosophy.

- The key focus areas should be:
  - Use of advanced technology to improve industrial processes that enhance the innovative and efficient use of forest and wood based products.

  - Value-adding forest products using environmental-friendly chemicals/materials and developing hybrid wood-based composite materials that are durable, termite and pest-free.

  - Identify new applications of the hybrid wood-based composite materials that may contribute to the development of the other industries and spawn new industries.

  - Traceability of forest products so as to ensure they adhere to global best practices and standards.

  - Development of genetic mapping methods, informatics tools and knowledge management systems to undertake traceability of source of timber and wood-based products.

- Target outcomes to be achieved is higher levels of process improvement and product development via technology/knowledge transfer, IPs, commercialisation of IPs/patents, management services, workshops trainings and consultancy.

Best Practice 4.6 from ***Case-Study - A New European Union Forest Strategy for Forest and Forest-Based Sector.***

Recommendation 4.7: Strengthen the Knowledge Leverage within the Forestry Industry

- Firms in the industry can benefit in terms of enhancing the dynamic capabilities of firms in the forestry industry by providing access to information on the following: experts and specialist; R&D infrastructure; training programs and course; workshops; new innovations and discoveries; funding agencies; global best practices and standards; business development services and other important information that will enhance the knowledge intensity and innovative capacity. One such framework that enables industry to provide a seamless flow of information and knowledge across the industry value chain is the adoption of Industry4.0 framework. Resources and support should be provided for firms to adopt Industry4.0 framework.

- Establishment of a Malaysian Forestry Network that is linked to other forestry networks from other countries will go a long way in providing local industry important market intelligence to assist them to make strategic decision to enhance their competitive and comparative advantage. Key research institutes (universities, GRIs and CoEs) can be important 'One-Stop Centres' for firms in the industry. The online portal can also be an important source of information for services such as access to financing, expertise, research infrastructure, new science & technology and discoveries related to the palm oil industry.

Best Practice 4.7 from ***Case-Study - A New European Union Forest Strategy for Forest and Forest-Based Sector.***

4.5 Conclusion

This chapter provides valuable information on the state of the knowledge ecosystem for the Malaysian forestry industry. The chapter identifies key strengths and gaps in the knowledge ecosystem of the forestry industry. Key policies and strategies to strengthen the forestry knowledge ecosystem, in particular the knowledge enablers, were provided in this chapter. Stronger knowledge enablers will lead to higher levels of dynamic capability of the industry. Thus raisinsg the levels of process improvement, product development and economic outcome of the industry.

Appendix for Chapter 4

Case-Study 4.1: A New European Union Forest Strategy for Forest and Forest-Based Sector

The European Forestry industry has come under intensive pressure due to increased pressure and demand from consumers, policy-makers and community organisations to meet environmental, social and economic global best practices and standards. These challenges can be summarized into the following:

- Mitigating the risks relate to climate change;
- The forestry industry being an important source of renewable energy;
- Protecting the forest reserves and sustainability of the industry due to climate change;
- Ensuring the biodiversity of the forest are protected and enhanced;
- Raising the competitiveness of forest products as alternate renewable products and energy;
- Ensuring appropriate policies, institutions and implementation mechanism are in place; and,
- Demonstrating and assisting all stakeholders in the forestry industry to achieve sustainable practices and outcomes.

Best Practice 4.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) within the Forestry industry

Major studies were undertaken to examine the challenges mentioned above and its impact on the European forestry industry. One of the study was by the United Nations Economic Commission for Europe and Food and Agriculture Organisation of the United Nations that provides the EU region a framework for aligning the directions of the industry to address the challenges mentioned above and ensuring the competitiveness and sustainability of the EU forestry industry. The key framework proposed is that governments in the EU realign their policies, regulations, institutions, incentives and capability development programs so as to address the following:

- Climate change mitigation strategy and reduction in carbon stock due to fire, pest, insects and pollution;
- Develop guidelines based on sound scientific evidence for firms to build resilience to climate change and global warming;
- Identify the skills set, technology and R&D activities that will enhance the yield, environmental sustainability and biodiversity, efficiency operational, mobilisation and demand for renewable forest products;
- Ensuring appropriate policy framework is in place to create a conducive and business-friendly environment, availability of support services and information portal to adhere to global best practices and standards; and,
- Raise the dynamic capabilities of the industry (absorptive, adaptive and innovative), spawning new sources of growth from renewable forestry products and services.

Best Practice 4.2: Enhance the Knowledge Institutional System of the Forestry industry

To ensure firms in the EU region transform the forestry industry into a knowledge intensive and prosperous bio-economy, key institutions should work together to assist with the implementation strategy. The roles of the key institutions are as follows:

- *Government agencies* – to map key challenges, milestones and KPIs to be achieved and the role of agencies to provide oversight to the implementation and, where needed, a framework for addressing inter-sectoral coordination among ministries and agencies. Ensuring that national standards and best practices are aligned with the EU guidelines. Further, clear objective methods of monitoring, audit and regulatory recourse for non-compliance are in place.

- *Industry associations* – scan the global markets on current trends, consumer preference, technological landscape, education and training of firms and other stakeholders. Industry associations are also key partners in the formulation of the strategic direction of the forestry industry. Industry associations also encourage sharing of information and knowledge within the country, region and globally.
- *Educational and research institutions* – align their R&D strategies to address the sustainability and competitiveness of the forestry industry. Hence, there is a focus on soil carbon, adaptation of environmentally friendly practices, forest monitoring, sustainability of wood supply, short rotation of coppice, optimal land use, non-forest wood supply, wood for energy, and new technology and models for forest management.

Best Practice 4.3: Develop the Knowledge Capital of the Forestry industry

- There is significant investment channelled into scientific, technological, economic, social science studies to ensure the forestry industry is sustainable and contributes positively to the bio-economy of the region. Substantial R&D for applied and translational research for the forestry industry has been allocated under the European Union funding programs (*Horizon 2020*). These funding are to scale up the knowledge capital and innovation among firms in the industry, especially the SMEs. Much of the research funding fosters strong university-industry research collaborations to solve problems encountered by the industry and push the knowledge frontier to raise the global competitiveness of the industry.

Best Practice 4.4: Develop the Knowledge Competency of the Forestry industry

- To raise the level of knowledge content in the forestry and related industries, the EU forestry industry put in a plan to raise the level of skilled and well-skilled workforce, by ensuring core skillset and competency requirements for all jobs in the forestry industry. The core competencies cover a wide range of job functions, including the following: global best practices and standards; forest growing and management; harvesting and haulage; sawmilling and processing; timber manufacturing and merchandising.
- Various capabilities training development programs and university and college courses have been established to ensure the knowledge capital is developed with the breadth and depth that caters to the entire forestry ecosystem. The funding for this initiative are from the existing funds such as the European Agriculture Fund for Rural Development, the European Regional

Development, the European Social Fund and the European Training Programmes. Among the key initiatives include providing greater awareness among the young about the career development programs in the forestry industry.

Best Practice 4.5: Facilitate Knowledge Learning & Transfer within the Forestry industry

- Most of the research institutes and universities that have focused research and education programmes in the EU cover a wide spectrum of areas within the forestry ecosystem that enhance the sustainability and competitiveness of firms in the downstream and upstream industry. These R&D initiatives have sound basic and translational components; and are often in partnership with key industry players. The research centres are also information and resource centres for the industry to obtain services (testing, screening, information and statistics). All of them have in-person and up-to-date online resources.

- There are substantial R&D funding allocated via Horizon2020 Funding Scheme to foster strong cooperation with industry and across research community in the EU region. One such institute that nurtures and fosters transnational R&D initiatives is the Finnish Forest Research Institute METLA (Finnish Forest Research Institute Metla, 2016)

Best Practice 4.6: Incorporate an Innovative Knowledge Approach within the Forestry Industry

- One of the approaches that is gaining momentum in the forestry industry in EU is the adoption of the Fraunhofer philosophy that focuses on the development of advanced science and technology to develop more sustainable forestry production, harvesting and management approaches. This leads to improved, more efficient and innovative forest and forest-based products, processes, business models and services. The approach will also aid in the discovery of new and sustainable use of forest products as an alternate renewable product; new technology; IP and commercialization opportunities; workshops and trainings that can be important revenue streams for the industry. An example of such a case study is the Fraunhofer- Renewable materials and healthy environments research and innovation centre of excellence (InnoRenew CoE), which was funded by Horizon2020 Programme (InnoRenew CoE, 2016).

Best Practice 4.7: Strengthen the Knowledge Leverage within the Forestry Industry

A number of countries in EU have adopted Industry4.0, where downstream and upstream forestry related industries are interconnected using machines, sensors, intelligent control systems and network. The seamless integration of production, supply, information, and knowledge channels has enabled the industry to achieve the following:

- Be agile in responding quickly to global market demand and changes;

- Adopt global best practices and standards and ensure compliance of these standards through real-time monitoring;

- Continuous and real time optimization of production and supply chain networks;

- Ability to customize products – both achieving economies of scale and scope;

- Use big data analytics to constantly monitor condition of plantations, performance of the harvesting and adherence to global best practices and standards.

- Access to valuable information and knowledge on all aspects on the forestry value chain enables policy-makers, industry associations, universities and research institutes and firms to make strategic decisions more quickly. It also enables these stakeholders to continuously refine and revise their policies and strategies to adopt and adapt to both internal changes taking place in the firms and industry and external changes taking place in the global markets. An example of such an initiative is the application of Industry4.0 for the forestry and paper industry called PapiNet, and initiative of the European Consortium (PapiNet, 2016).

References:

1. European Commission. (2013). A New EU Forest Strategy: For Forests and the Forest-based Sector, EU Commission Report. Retrieved from http://ec.europa.eu/agriculture/forest/strategy/communication_en.pdf

2. Finnish Forest Research Institute Metla. (2016). *Home*. Retrieved from http://www.metla.fi/index-en.html

3. InnoRenew CoE. (2016). *Renewable Materials and Healthy Environments Research and Innovation Centre of Excellence* (InnoRenew CoE). Retrieved from http://innorenew.eu/en/

4. Malaysian Timber Council. (2016a). *Home*. Retrieved from http://mtc.com.my

5. PapiNet. (2016). *Home*. Retrieved from http://www.papinet.org

6. United Nations Economic Commission for Europe and Food and Agriculture Organization of the United Nations. (2011). *The European Forest Sector Outlook Study II*: 2010-2030, United Nations, Geneva. Retrieved from http://www.fao.org/docrep/016/ap406e/ap406e00.pdf .

CHAPTER 5

KNOWLEDGE CONTENT OF THE MALAYSIAN FISHERY INDUSTRY

CHAPTER 5
Knowledge Content of the Malaysian Fishery Industry

5.0 Introduction

In this chapter, we examine the knowledge ecosystem of the fishery industry, an industry that is an important source of animal protein for Malaysia. The industry is classified into four categories, namely: marine fishing, freshwater fishing, marine aquaculture and freshwater aquaculture. The demand for fish in Malaysia is on an upward trend, and is expected to increase from 1.3 million metric tonnes in 2010 to 1.9 million metric tonnes in 2020. The per capita consumption is predicted to increase from 46 kilograms to 55 kilograms over the same period[6]. The fishing industry has also contributed close to RM10.22 billion in 2015 and is envisaged to grow annually by 4.9%, contributing close to RM12.96 billion to the Malaysian economy by 2020[7].

While the industry is an important source of food for the nation, the demand for fish-based protein outstrips the supply generated by the local industry. To make up for the shortfall in demand, the country imports fish and aquaculture from other countries in the region. The local fishing industry also faces a number of challenges, which include[8]:

- Under-reporting of fishing and aquaculture catch due to unlicensed traditional fishermen and unlicensed vessels in Malaysian waters;
- Close to 73% and 62% fishermen are micro and small operators who treat fishing as a part-time or season job. Hence, the effort level to raise their productivity is low;
- Tracking and recording of fish catch and landing by the relevant authorities are not well documented. Hence, the pool of fish, type and quality of fish caught are not well documented. This can lead to over-exploitation of local fish stock, thus hindering the long-term sustainability of the industry;
- The industry still maintains traditional practices, resulting in high 'trash fish', which diminishes the value of the catch;
- Increasing cost of doing business due to fuel price and other cost; and
- Quality of marine and aquaculture is adversely impacted by industrial wastes, sewage discharge, coastal land reclamation, illegal dumping of sludge from ships and oil spill.

Besides the above threats to the sustainability of the fishing industry, countries in the region such as Indonesia, Thailand, Taiwan and others have put in place plans and strategies to move the fishing industry up the knowledge and innovation value chain. This will not only enable fishing industries in these countries to operate efficiently and in a sustained way, but also enable the local operators to raise the quality of catch.

To ensure the Malaysian fishing industry raises its regional competitiveness, the fishing ecosystem requires a major overhaul to become more knowledge intensive. In this chapter, we assess the knowledge ecosystem of the fishery industry using the MYKE-III knowledge ecosystem model for a sample of 52 firms operating in Malaysia. From the sample, 4 are large firms, 48 are micro-SMEs, 46 local and 6 foreign firms. In the sample, the data covers all four sub-industries: marine fishing; freshwater fishing; marine aquaculture; freshwater aquaculture

The chapter is organised as follows: In Section 5.1, a description of the knowledge ecosystem of the fishing industry in an advanced country is provided. In Section 5.2, we provide a description of the knowledge ecosystem for the Malaysian fishing. In Section 5.3, the key strengths and gaps in the Malaysian fishing ecosystem are discussed. In Section 5.4, key recommendations to improve the knowledge ecosystem of the Malaysian fishing industry are provided, concluding in Section 5.5.

5.1 Knowledge Ecosystem for the Fishery Industry in an Advanced Country

Fish and marine aquaculture are a main source of food for most developed countries. As such, significant resources are channelled into developing the fishing industry ecosystem to become knowledge intensive, enabling the industries to enhance economies of scale. Examples of countries with a highly knowledge intensive fishing industry include Australia, Canada, USA, Japan and the Nordic countries. The knowledge ecosystem of the fishery industry in these countries is captured in Figure 5.1. The fishery ecosystem shows the complex relationship between knowledge enablers, dynamic capabilities and outcomes. The figure shows that knowledge enablers are strong in supporting the development of all three components of dynamic capabilities. Furthermore, the strong dynamic capabilities in these countries could lead to both process improvements and new product developments, which contribute to the economic outcomes of the industry.

[6]Economic Planning Unit. (2015). *Strategy Paper 20, Prime Minister's Department.* Retrieved from http://rmk11.epu.gov.my/pdf/strategy-paper/.

[7]Economic Planning Unit. (2015). *Strategy Paper 20, Prime Minister's Department*. Retrieved from http://rmk11.epu.gov.my/pdf/strategy-paper/.

[8]Sources: Teh, L., & Teh, L. (2014). Reconstructing the Marine Fisheries Catch of Peninsula Malaysia, Sarawak and Sabah, 1956-2010. Fishery Centre Working Paper, The University of British Columbia, Vancouver, BC, V6T, 1Z4, Canada. Retrieved from http://publications.oceans.ubc.ca/node/4710. Also, refer to World Wild Fund (2013), An Assessment of Fisheries and Marine Ecosystem in Peninsula Malaysia. Retrieved from http://www.saveourseafood.my/wp-content/uploads/resourcesreports/an_assessment_of_fisheries.pdf

To ensure long-term sustainability of the fishery industry, most advanced countries invest significant resources in the development of the knowledge enablers. Among the key initiatives undertaken are outlined below:

- *Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the fishery industry* – ensure that the plans, policies and strategies implemented are appropriate to institutional governance, talent development, investment in R&D towards focused areas, adequate support systems and regulatory architecture to promote global best practices and standards in the local industry. *Best Practice 5.1: Efficient & Sustainable Management of Commonwealth Fish Resource, Australian Fishery Corporate Plan 2015-2018 and Seafood Standards – Food Standard Australia New Zealand.*

- *Enhance the Knowledge Institutional System of the Fishery Industry* – establish strong government institutions and agencies to provide leadership in ensuring the sustainable development of the fishing industry. The institutions have dual roles of mobilizing support from industry associations and industry in creating a culture of innovation and continuous improvement as well as ensuring compliance to global best practices. These institutions also play a key role in fishery border protection and legal recourse for non-compliance to standards and regulations. *Best Practice 5.2: The Australian Fishery Management Authority.*

- *Develop the Knowledge Capital of the Fishery Industry* – put in place policies, support systems and incentives for the industry to professionalise the work force. This is done by strengthening the existing institution of learning, colleges and universities, to design training programs and courses that enable the fishing community to upgrade their skills and training to be more knowledge intensive. Resources are channelled to firms for them to gain access to new technology, scientific discoveries, new management systems and processes and financial systems that enhance operational efficiency, productivity and increase the value of their catch. The programs should clearly map a career path for workers in the industry. *Best Practice 5.3: Australian Maritime & Fishery Academy.*

- *Develop the Knowledge Competency for the Fishery Industry* – the industry is changing rapidly due to converging technology platforms and knowledge systems. Most advanced countries have dedicated agencies that are continuously monitoring the changes taking place and put in place curriculum reforms in the trainings and education systems to nurture and develop the skill set and competencies required by the industry. *Best Practice 5.4: Comprehensive Australian Skills Development Framework.*

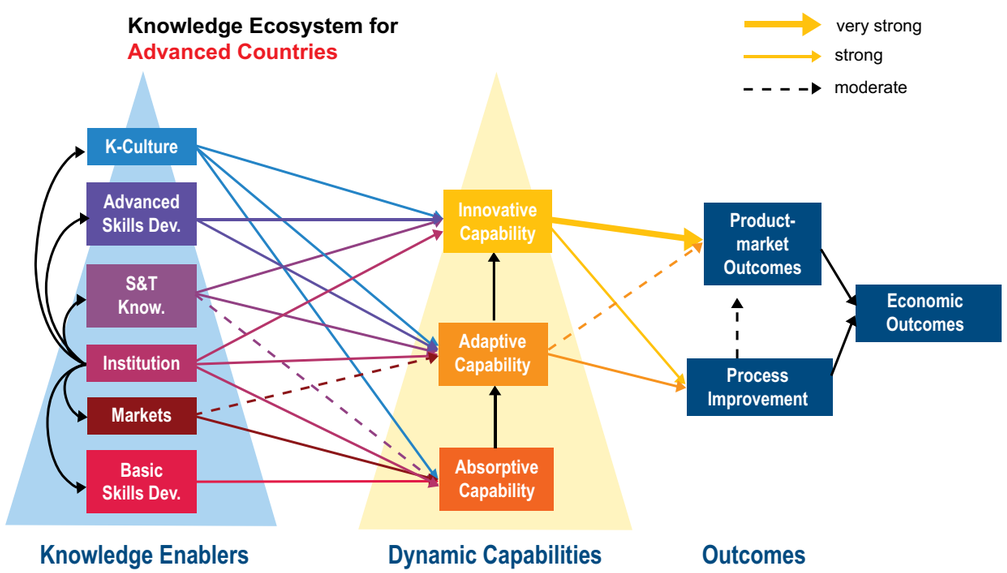
- *Facilitate Knowledge Learning and Transfer within the Fishery Industry* – in most advanced countries, educational and research institutions have been endowed with grants and support systems to spearhead R&D and innovations that will lead to new process improvements and product development in the fishery industry. There is strong support for basic R&D and applied research that will directly benefit firms in the fishing industry. Major education and research programs have been established in leading universities jointly with industry players to ensure that there is a steady flow of talented workers and R&D activities that will raise the knowledge content of the local fishing industry. *Best Practice 5.5: Smart Partnership led by Fishery Research and Development Corporation in Australia.*

- *Incorporate an Innovative Knowledge Approach within the Fishery Industry* – the research undertaken by GRIs is targeted and focused in addressing the challenges faced by the industry and provides ways to enhance their competiveness. The industry also has access to a wide range of facilities to test their products, use or license some of the technology developed by the universities and GRIs, and jointly commercialise the innovations development by the universities and GRIs. The firms can engage leading experts from universities and GRIs to assist them in building knowledge content and enhancing their dynamic capabilities. *Best Practice 5.6: Aquaculture Research in Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia.*

- *The Ecosystem Has Very Strong Knowledge Leverage within the Fishery Industry* – In developed countries, the government works closely with the industry and industry associations to establish key institutes or centres that play multiple roles of undertaking R&D, providing training and becoming an important knowledge resource for the industry. *Best Practice 5.7: The Australian Seafood Cooperative Research Centre.*

Example of best practices of the above is given in ***Case-Study 5.1: The Australian Seafood Cooperative Research Centre.***

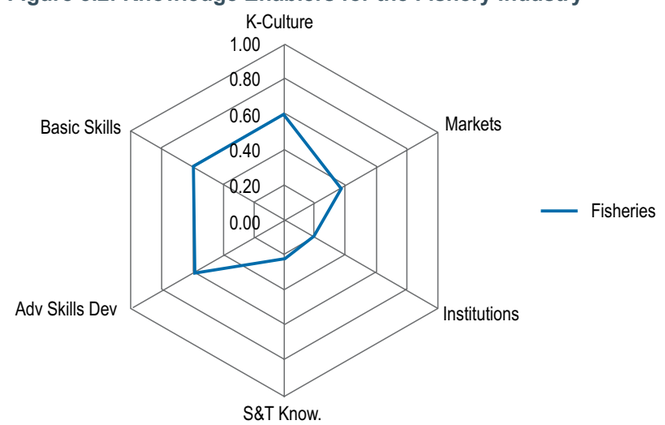
Figure 5.1: Complex Relationships in the Fishery Industry in an Advanced Country



5.2 Knowledge Ecosystem of the Malaysian Fishery Industry

The knowledge ecosystem for the Malaysian fishery industry is discussed in this section. Figure 5.2 shows the state of development of the knowledge enablers for the fishery industry. Three of the knowledge enablers (institutions, market intelligence and S&T knowledge) are very low (below 0.4); while three of enablers (basic skills, advanced skills and k-culture) are performing at the moderate level, above 0.5.

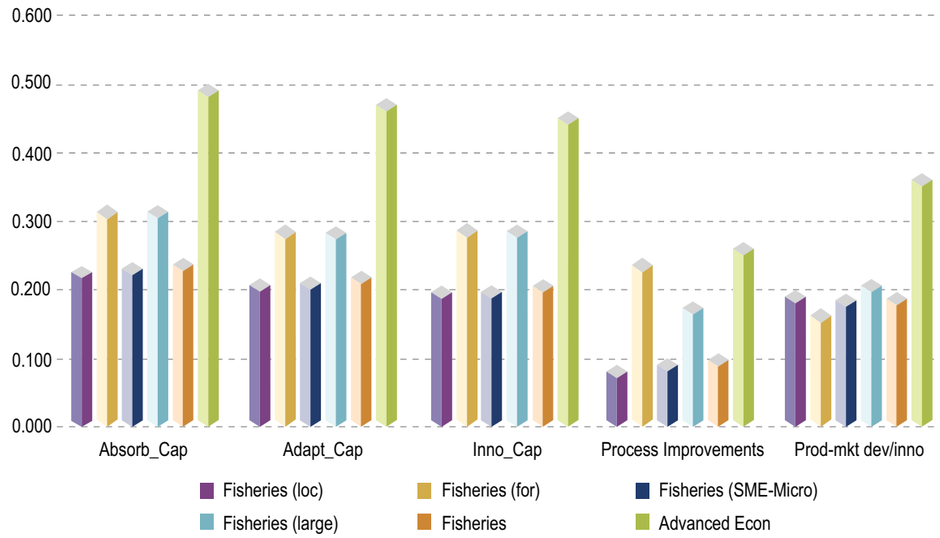
Figure 5.2: Knowledge Enablers for the Fishery Industry



The performance of the dynamic capability components, process improvement and product development for the Malaysian fishery industry are shown in Figure 5.3. The dynamic capability, process improvement and product development for advanced countries were found to be significantly higher than that of the Malaysian fishery industry. Within the Malaysian fishery industry, foreign firms were found to have significantly higher absorptive, adaptive and innovative capability than local firms. Similarly, larger firms were found to have higher absorptive, adaptive and innovative capabilities than micro-SMEs. The figure also shows that foreign and larger firms have higher process improvements than local and micro-SMEs, respectively. Further, larger firms were found to have slightly higher product market development than micro-SME. Local firms were found to have higher product market development than foreign firms.

The strategic postures of firms are given in Figure 5.4. It shows that the percentage of Analyser firms in this industry is 35%; Defender is 21%; Reactor is 8%; and, Defender-Analyser is 10%. Approximately 6% in this industry are Prospector firms. Close to 19% pursue mixed strategies; this demonstrates

Figure 5.3: Dynamic Capabilities of the Fishery Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

Figure 5.4: Strategic Posture of the Firms in the Malaysian Fishery Industry

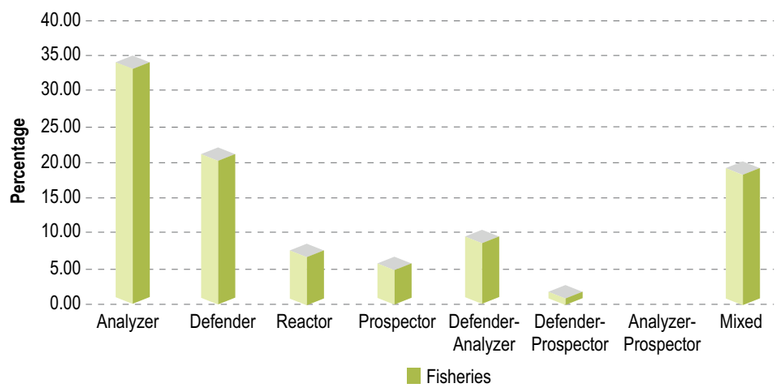
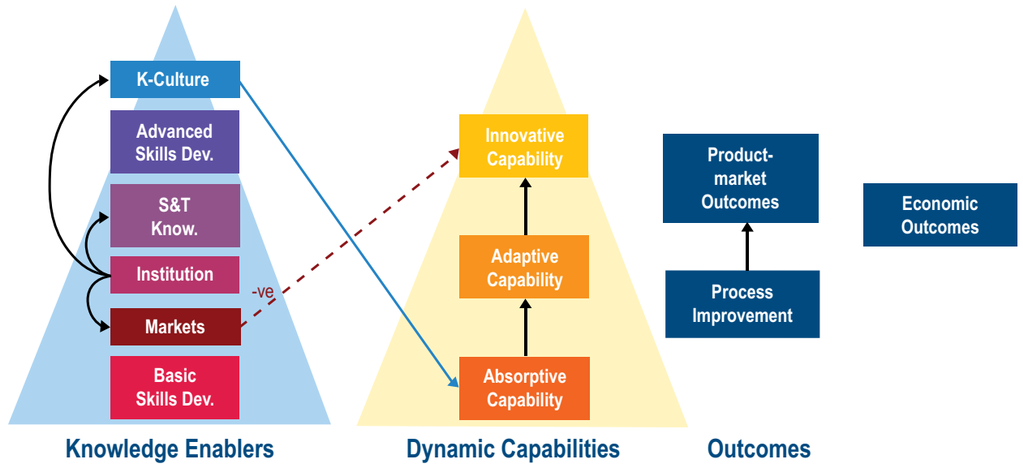


Figure 5.5: Knowledge Ecosystem of the Fishery Industry



that this segment of firms do not pursue a consistent strategic direction that can lead to positive outcomes. The analysis suggests that only a small percentage of firms in this industry are highly innovative (6%) in charting a competitive direction.

The Malaysian fishery knowledge ecosystem is shown in Figure 5.5 and it shows that institutions are important in developing the key enablers, with the exception of basic skills. This is not surprising as a majority of the fishing community uses traditional fishing methods and employs large pools of transient foreign workers. The institutions were also found to have no impact on the dynamic capability components for the fishery industry with the exception of knowledge culture and market intelligence. Market intelligence was found to have a negative impact on innovative capability. The rationale for these results is that firms that do not invest in talent and technology and yet try to be innovative will not be successful, as the foundation condition for such endeavours are not present. Furthermore, any innovation undertaken will lead to a poor return of investments and incur a high opportunity cost. These innovations may also be inferior and lead to reputational problems.

The empirical analysis also suggests that knowledge culture has a positive impact on absorptive capability. This suggests that firms recognise the importance of new knowledge and technology for the survival of the firms, and therefore encourage the use of modern technology and innovations. However, due to a lack of other supporting enablers, the impact of the dynamic capability on process improvement and product development is not significant. Hence, the impact of knowledge and innovation on the economic outcomes of the industry are not statistically significant. This suggests that the knowledge ecosystem is weak and the industry's economic development is primarily dependent on labour intensive practices and low-technology operations.

5.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Fishery Industry

The empirical analysis in Figure 5.5 shows that the knowledge ecosystem for the fishery industry has some strengths and gaps that are discussed below.

Key Strengths of the Fishery Ecosystem:

- This industry receives strong support from the Malaysian government and is evidenced by the incentives and support schemes provided under the various 5-year economic plans, including the recent 11th Malaysia Plan. Under the plan, significant investment is channelled to achieve the following:
  - Increase the quality of fishes through the various breeding centres across the country;

- Increase the productivity of micro-SMEs;
- New zones have been identified and use of high-tech has been proposed to increase the quality of aquaculture;
- Increasing the quality of fish feed;
- Greater adherence to global best practices and standards; and
- Strengthening of coastal fishing community and deep sea fishing through better access to training, education and technology.

- The aquaculture is also seen as a key priority area under the Economic Transformation Programmes (ETP).

- There have been several institutions established to spearhead the capability development programs, training, education and R&D activities. Among them include University Pertanian Malaysia, Universiti Malaysian Terengganu (UMT), the establishment of the Institute of Oceanography in UMT, Borneo Marine Research Institute (BMRI), Universiti Malaysia Sarawak (UNIMAS), University Science Malaysia (USM), University Selangor (UNISEL) and University Malaya.

Key Gaps Fishery Industry Ecosystem:

While there have been significant number of initiatives undertaken by the government to raise the knowledge content of the industry, there are numerous gaps in the Malaysian fishery ecosystem which hinder its move up the innovation value chain. The gaps in the ecosystem are discussed below.

- The institutions within fishery industry do not directly influence the dynamic capability components. Hence, the levels of knowledge content are low and its contribution towards wealth creation in this industry is low.

- The reason the institutions are not effective in influencing the dynamic capabilities is a lack of expertise and technological sophistication to foresight the changes taking place in the industry. The key agencies that are planning and providing oversight to the development of the industry lack the technical capabilities or resources to support knowledge development in the industry.

- The various educational programmes adopt a traditional approach in teaching and training graduates. Very few institutions train and educate the next generation of knowledge workers to be tech-savvy, have multidisciplinary skills, and are familiar with technology platforms that seamlessly integrate multiple complementing industries. In most advanced countries, the use of 'Fraunhofer approach' and 'Industry 4.0' philosophy are common features in training and course curriculums.

- While the Malaysian government has allocated substantial resources for R&D, the role of the private sector in contributing to these R&D activities is negligible. The public-private partnership model within the industry is weak. Hence, a majority of firms do not utilise the knowledge developed in universities and GRIs due to a lack of collaboration, resulting in R&D activities not meeting the industry's needs.

- Low levels of use of sophisticated technology and knowledge management systems result in suboptimal outcomes and market failures such as illegal fishing, under-reporting of catch, inability to capture information on the quality of catch and high amounts of 'trash fish'.

- Low adoption of technology among fishermen also hinders their ability to access vital information on services and support systems provided by government. They are also unable to obtain important market intelligence and market information and are therefore dependent on government agencies and other intermediaries. That latter tends to lead to exploitation of the fishermen.

- Large amounts of funding for building knowledge content are injected by the federal government. However, areas designated for fishing is the jurisdiction of the state governments. Diverging vision and interest of the state and federal governments can impede the implementation of programs and initiatives to raise the knowledge content of the fishing industry.

5.4 Recommendations to Improve the Malaysian Fishery Ecosystem

The fishery industry is critical for the food security of the country and is a source of employment for many people, especially in the coastal regions of Malaysia. To ensure the industry builds knowledge content and becomes a regionally competitive and sustainable industry, the following recommendations are proposed.

Recommendation 5.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) within the Fishery Industry

The Malaysian fishing industry is plagued by a number of challenges mentioned above. Furthermore, the global competitiveness of the fishing industry, similar to the agriculture crops industry, is governed by its ability to adhere to global best practices and benchmark standards. In most advanced countries, the fishing industry is governed by regulations pertaining to harvesting, processing, storing and selling seafood. To ensure that the output of the industry is globally competitive, they must adhere to several Acts and global standards pertaining to the Environment, Health, Food, Animal Welfare and Biosecurity.

To meet these global standards and best practices, the Malaysian fishing industry will be required to increase investment in talent development, infrastructure, technology, governance systems, monitoring, surveillance and other support systems. Knowledge of the best practices and standards should be a core teaching in all trainings and educational programs.

Best Practice 5.1: Efficient & Sustainable Management of Commonwealth Fish Resource, Australian Fishery Corporate Plan 2015-2018 and Seafood Standards – Food Standard Australia New Zealand.

Recommendation 5.2: Enhance the Knowledge Institutional System of the Fishery Industry

The fishing industry is an important contributor to the Malaysian economy and employment. To ensure the industry becomes knowledge intensive, a National Fishery Council chaired by the Minister of Agriculture is proposed. The council should have the Menteri Besars, industry associations, leader of key government agencies, GRIs and universities to work as a team to develop a strategic plan that enhances the knowledge enablers of the fishing ecosystem. Among the key initiatives of the plan include the following:

- Focus R&D in priority areas, and ensure that scientific and economic research guide decision making of the industry - incorporate Industry4.0-type framework in raising the knowledge content of the industry.

- Continuous tracking of performance of the industry with clear and tangible target and outcomes should be in place – data on the performance of the industry should be readily available to all stakeholders.

- Adequate financial support for research, development, innovation, commercialisation and other support mechanism to promote the generation of IP.

- Sound regulatory and governance architecture to prevent rent-seeking behaviour, illegal fishing; as well as adherence to global best practices and standards should be in place.

- Adequate business services support should be available to the fishing community – key enabler for improving the dynamic capability components of the firms (absorptive, adaptive and innovative capabilities), and enabling them to enhance their reach for resources, information, knowledge and markets.

Best Practice 5.2: The Australian Fishery Management Authority

Recommendation 5.3: Develop the Knowledge Capital of the Fishery Industry

- Professionalising the workforce will lead to adherence to global best practices in the industry, which will yield a more sustainable and competitive fishing industry.

- To ensure the industry has an adequate supply of professionally qualified personnel, certificate, diploma and higher level qualifications should be designed to meet the needs of an industry that increasingly becomes knowledge intensive. These programs should be certified by relevant local and international agencies.

- The training programs cover a wide range of areas in the fishery and seafood industry, which include the use of latest technology such as radar operations, GPS, shipboard safety & security, food handling and safety standards as well as cold-chain process.

- These training programs should map clear career pathways in commercial fishing, aquaculture, aquaculture hatchery and land base, seafood processing, seafood marketing and distribution, and fisheries compliance officers.

Best Practice 5.3: Australian Maritime & Fishery Academy

Recommendation 5.4: Develop the Knowledge Competency of the Fishery Industry

- The fishing industry should focus on developing core competencies, skills standards and qualifications, covering the following:
  - Fishing sector competency – deckhands, fishers, skippers of fishing vessels, managers of fishing operations, business managers, drivers and charter operators.

  - Aquaculture sector competency – field hands, technicians, supervisors, quality assurance officers, operations manager and aquaculture business managers.

  - Seafood processing, sales and distribution – post-harvest workers, which include process workers, seafood retailers, wholesalers, importers and exporters.

  - Seafood compliance sector – compliance officers, supervisors, managers and halal certification specialist.

  - Environmental Management Systems sector – officers, supervisors and managers that provide oversight to environment, food safety and quality, occupational health and safety.

  - Business services - financial specialist, public relations, legal, marketing and branding.

  - Innovations & Technology – scientists, researchers and technologist.

- Appropriate mechanisms should be in place to continuously review the core competencies so as to ensure that the industry keeps pace with the global trends and developments in more advanced countries

Best Practice 5.4: Comprehensive Australian Skills Development Framework

Recommendation 5.5: Facilitate Knowledge Learning & Transfer within the Fishery Industry

- The fishing industry should focus its innovation efforts in key priority areas that Malaysia has competitive and comparative advantage – prioritise R&D activities in areas that are strategic to the development of the local fishing industry.

- Strengthen existing CoEs and universities in the fishery industry – support should be provided to develop innovative fishing techniques and technology, management systems, logistic supply chains, post-harvest methods, financial models, marketing and branding.

- The CoEs and universities should work closely with the industry to transfer technology to the fishing industry, modelled after the Australian Fisheries Management Authority and Fishery Research and Development Corporation.

Best Practice 5.5: Smart Partnership led by Fishery Research and Development Corporation in Australia

Recommendation 5.6: Incorporate an Innovative Knowledge Approach within the Fishery Industry

- Strengthen the centres of excellence (CoEs) and institutes in the fishing and aquaculture by incorporating the "Fraunhofer" philosophy in the fishing industry – improve the knowledge content and competitiveness via translational and applied research.

- This includes focussing on R&D in areas that is strategic to the development of the local industry such as:
  - Novel fish eco-friendly farming and cultivation techniques;
  - Use of advanced technology (nanotechnology, nanomedicine and biotechnology) for sustainable fishing practices;
  - Development of novel fishing and post-harvest methods to sustain the quality of aquaculture.

- Foster strong research collaboration between CoEs, universities and industry.

- Target outcomes to be achieved are: higher levels of process improvement and product development via technology/knowledge transfer, IPs, commercialisation of IPs/patents, management services, workshops trainings and consultancy.

Best Practice 5.6: Aquaculture Research in Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia.

Recommendation 5.7: Strengthen the Knowledge Leverage within the Fishery Industry

- Establish a knowledge network consisting of research institutes, subject specialists, training institutes, libraries, industry associations, government agencies, funding bodies, financiers and other stakeholders, who are dedicated to providing a "one-stop-portal" for information and services that are required by the fishing industry.

- The portal should include the following information:
  - Experts in the country and overseas;
  - Full-text and web-resources, especially new discoveries, best practices and standards in the field;
  - Grants, financial support, and other business services support;
  - Key national and international industry associations and networks;
  - Access to laboratories and R&D facilities; and
  - Organise forums, exhibitions, workshops and training programs for the fishing industry.

Best Practice 5.7: The Australian Seafood Cooperative Research Centre

5.5 Conclusion

This chapter provided valuable information on the state of the Malaysian fishing industry knowledge ecosystem. The chapter identified key strengths and gaps in the knowledge ecosystem. Key policies and strategies to strengthen the knowledge ecosystem, in particular the knowledge enablers were provided in this chapter. The stronger knowledge enablers will lead to higher levels of dynamic capability of the industry, thus raising the levels of process improvement, product development and economic outcome of the industry.

Appendix for Chapter 5

Case-Study 5.1: The Knowledge Intensity and Sustainability of the Australian Fishery Industry

The Australian fishing and aquaculture industry is one of the most advanced and competitive industries in the world, contributing close to A$2.4 billion total gross value of production (GVP) and employs close to 11,600 jobs (7,300 directly and 4,300 indirectly) in the Australian economy[9]. The industry has experienced intense pressure over the last decade due to a number of factors that are outlined below:

Illegal fishing, unlicensed and encroachment of foreign vessels into Australian waters;
Overfishing and depletion of stocks of fish;

- Environmental issues, climate change and ensuring biodiversity of sea are protected and enhanced;
- Impact of global warming and environmental degradation on the stock and quality of fish and aquaculture;
- Increasing cost of doing business;
- Increasing competition from other regional economies;

To address the above-mentioned concerns, a number of strategies have been put in place to transform the industry into a knowledge-intensive and competitive industry.

Best Practice 5.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) within the Fishery Industry

The Australian government established the Australian Fisheries Management Authority (AFMA) to develop a framework to ensure the industry addresses the above-mentioned concerns and the industry is operating competitively in a sustainably. These include ensuring the following are achieved:

- Ensuring compliance to licensing agreements with domestic and foreign vessels to curb illegal fishing;
- Ensuring that the appropriate surveillance and monitoring are undertaken using advanced technology to curb illegal fishing and ensuring sustained stock of fish and aquaculture in Australian waters;
- Put in place policies to ensure effective and efficient management of stock and quality of fish and aquaculture through:
  - Joint participation with industry on stock assessment;
  - Development of optimal harvesting strategies, including stock rebuilding, by-catch management and protection of endangered species;
  - Development of key infrastructure, expertise and support service to ensure sustainability of rural fishing communities;
  - Providing funding for R&D activities in key priority areas that will raise the knowledge content and innovative capacity of the local fishing industry; and
  - Participate in regular surveys, data collection and studies to inform policy decision and direction of the industry.

[9]Source: Australian Fisheries Management Authority. (2014). Corporate Plan 2014-2017. Retrieved from http://www.afma.gov.au/wp-content/uploads/2014/04/AFMA-Corporate-Plan-2014-17.pdf and the Australian Fisheries Management Authority. (2015). Corporate Plan 2015-2018. Retrieved from http://www.afma.gov.au/wp-content/uploads/2015/07/AFMA-2015-2018-Corporate-Plan.pdf

Best Practice 5.2: Enhance the Knowledge Institutional System of the Fishery Industry

The Australian Fishery Management Authority was established to ensure the Australian fishing industry develops in a sustainable and profitable way. These objectives are supported by a strong push for cost-effective management, compliance to local regulations and international standards, fishery border protection, licensing and cost recovery for the industry to raise its standards. The governance framework clearly articulates the roles, responsibilities and mechanism for ensuring managing risks, performance, compliance, engagement with key stakeholders, development and information management. Source: Australian Fisheries Management Authority (2016).

Best Practice 5.3: Develop the Knowledge Capital of the Fishery Industry

To ensure that the industry has adequate knowledge capital, several universities and training institutes were established from scientific, management, regulatory, branding and marketing expertise. One of the institutions that is contributing to the up-skilling of the knowledge capital of the industry is the Australian Fisheries Academy, which was established in 1997. The Academic is now recognised as a leader in providing training and education for Australian maritime, fishing and seafood industry. In 2011, the academy changed its name to Australian Maritime and Fisheries Academy (AMFA) with a view to deepen knowledge in the maritime sector, which is close related to the fishing and aquaculture industry. AMFA is regarded as providing the highest standard of certified practical industry-relevant trainings that meet the needs of the industry, using latest maritime and communication technology. The programs can be customised to meet industry specific requirements. The Academy has a wide range of experienced experts and mentors that can assist the industry and its network so as to ensure the firm is able to fully integrated service in the fishing and aquaculture industry. For more details on the programs provided by the Academy, refer to Australian Maritime and Fisheries Academy (2016).

Best Practice 5.4: Develop the Knowledge Competency of the Fishery Industry

The Australian government has established a number of committees and agencies to provide systematic and comprehensive development of the skills needed of the industries in Australia, including the fishery industry. Key committees and agencies are:

- *Australian Industry and Skills Committee (AISC)*: provides advice to the government on vocational education training (VET), provides quality assurance and approves the courses and training offered by the training providers (for more information: Australian Industry and Skills Committee (2016)).
- *Australian Skills Quality Authority (ASQA)*: a national regulatory body for the vocational education and training (VET) sector – all training programs and courses have to be approved to meet the established quality standards (for more information: Australian Skills Quality Authority (2016)).
- *Department of Education & Training (DEST)*: provides oversight to the education and training policies pertaining to quality and access to all segments of the workforce – the office is responsible for ensuring the success of education and training programs (early childhood, school education, higher education, vocational education and training, international education and research). The agency ensures that adequate resources and support is given to nurture a creative and innovative workforce for the fishery industry (for more information: Australian Government Department of Education and Training (2016a)).
- *VETNet*: an initiative of DEST that provides a repository of information on all the VET programs apprentice and traineeships, courses and training programs, and a national registry of VET programs (for more information: Australian Government Department of Education and Training. (2016b)).

Best Practice 5.5: Facilitate Knowledge Learning & Transfer within the Fishery industry

The Fishery Research Development Corporation (FRDC) was a joint partnership between the Australian government and the fishery industry to enhance R&D and extension programs. The R&D and extension programs are in key strategic areas and target priority challenges for the industry. The beneficiaries of this programs are the diverse sectors of the fishing industry, which include commercial (fish and aquaculture); recreational, indigenous and rural communities. The FRDC also is an important knowledge resource on a wide range of information on current technology, scientific discoveries, environmental issues, and best practices and standards for the fishing community. For more information, see: Fisheries Research and Development Corporation (2016).

Best Practice 5.6: Incorporate an Innovative Knowledge Approach within the Fishery Industry

Commonwealth Scientific and Industrial Research Organization (CSIRO) is a leading GRI in Australia that undertakes targeted R&D activities that are relevant to the development of the fishery and aquaculture industry. The R&D is undertaken jointly with the industry which pioneers new innovations in improving the nutritional value of the fishery and aquaculture catch; new design and genetically-superior species of fish and aquaculture; new breeding technique that leads to high yield and quality of the stock of fish and aquaculture; create new elite species of fish and aquaculture; better quality of aquaculture feed and addressing diseases related to the fish and aquaculture.

CSIRO also hosts a wide range of other research platforms, facilities, experts and industry linkages such as in agriculture & food, animal & plants, farming & food production, health, indigenous engagement, information and communication technology, synthetic biology, environomics (sustainable development ecosystems) and probing bio-systems. The wide range of disciplinary research and expertise enables the fishing industry to identify solutions to some of the challenges from a multidisciplinary perspective. This helps the industry discover new innovations that generate IPs, patents, technological developments, knowledge management systems and trainings. This opens up new revenue streams for the industry. For more information, refer to: Commonwealth Scientific and Industrial Research Organisation [CSIRO]. (2016).

Best Practice 5.7: Strengthen the Knowledge Leverage within the Fishery Industry

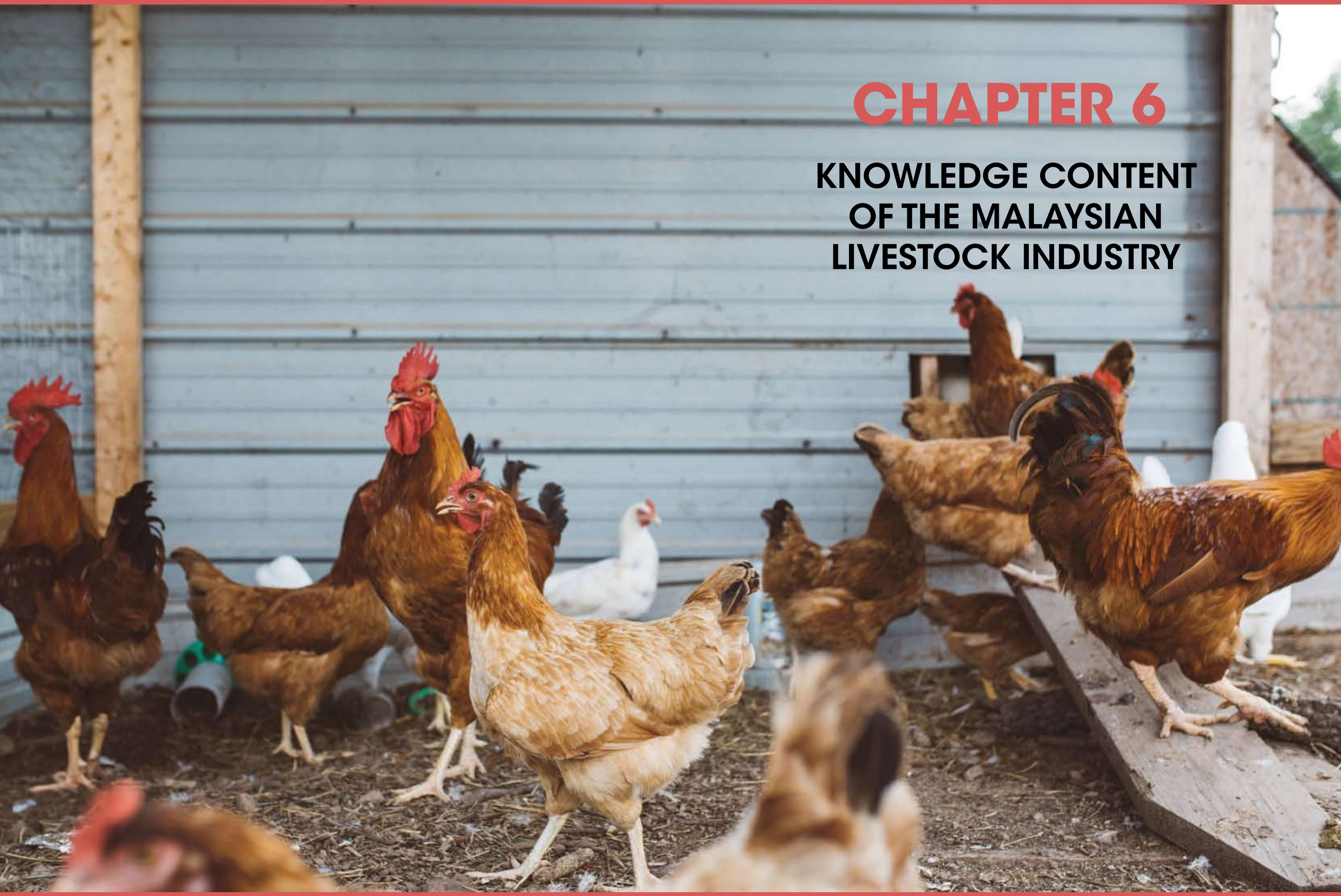
The Australian government has established a number of Cooperative Research Centres (CRC) to be the creator of new knowledge, and also to disseminate the knowledge through a network of partnerships and information resources. Among the key initiatives to strengthen the knowledge leverage include CSIRO and Seafood Cooperative Research Centre (ASCRC). ASCRC was established under the Australian government's CRC program, in partnership with Fisheries Research and Development Corporation and industry. The ASCRC fosters strong partnerships between the research community, universities, industry, community group and government to address some of the grant challenges of the industry. All CRC funded program would require at least one university industry partner. The information portal and resources are rich in content and has extensive reach in the community in terms of providing valuable information on cutting-edge R&D, expertise, trainings and other valuable information and services that benefit the fishing industry. For more information, refer to: Australian Seafood Cooperative Research Centre (2016).

References:

1. Australian Fisheries Management Authority. (2016). *Home*. Retrieved from www.afma.gov.au
2. Australian Government Department of Education and Training. (2016a). *Home*. Retrieved from https://www.education.gov.au/
3. Australian Government Department of Education and Training. (2016b). *About VETNet*. Retrieved from https://vetnet.education.gov.au/Pages/default.aspx
4. Australian Industry and Skills Committee. (2016). *Home*. Retrieved from https://www.aisc.net.au/
5. Australian Maritime and Fisheries Academy. (2016). *Home*. Retrieved from http://www.afa.edu.au/index.html
6. Australian Seafood Cooperative Research Centre. (2016). *Home*. Retrieved from https://www.seafoodcrc.com/
7. Australian Skills Quality Authority. (2016). *Home*. Retrieved from http://www.asqa.gov.au/
8. Commonwealth Scientific and Industrial Research Organisation [CSIRO]. (2016). *Home*. Retrieved from https://www.csiro.au
9. Fisheries Research and Development Corporation. (2016). *Home*. Retrieved from http://frdc.com.au/Pages/home.aspx

CHAPTER 6

KNOWLEDGE CONTENT OF THE MALAYSIAN LIVESTOCK INDUSTRY



CHAPTER 6
Knowledge Content of the Malaysian Livestock Industry

6.0 Introduction

The knowledge ecosystem of the livestock industry (cattle, buffaloes, swine, pigs, poultry and other animals) is examined in this chapter. This industry is an important source of animal protein for the Malaysian population; it contributed a total of RM10.3 billion in 2015 and is envisaged to increase to RM12.8 billion by 2020, achieving an annual growth rate of 4.5% per annum from 2016 to 2020[10]. While the industry is expected to expand over the next few years, the national food bill for meat and meat preparation remains in a deficit of 14.7%[11]. Furthermore, the Self-Sufficiency Level (SSL) for key meat products are as follows: beef (27.2%), mutton (17.3%), poultry (104.6%), pork (88.7%), eggs (122.1%), milk (13%), while dairy products is 12.8%[12]. This suggests that the local livestock industry is unable to meet the domestic demand for beef, mutton, pork, milk and dairy products. Hence, Malaysia incurs a large food bill for importing some of the above mentioned meats and dairy products. This has major ramifications on ensuring food security of the country and the financial position of the country.

[10]Source: Economic Planning Unit. (2015). Strategy Paper 20, Prime Minister's Department. Retrieved from http://rmk11.epu.gov.my/pdf/strategy-paper/.

[11]Source: Economic Planning Unit. (2015). Strategy Paper 20, Prime Minister's Department. Retrieved from http://rmk11.epu.gov.my/pdf/strategy-paper/.

[12]Source: Economic Planning Unit. (2015). Strategy Paper 20, Prime Minister's Department. Retrieved from http://rmk11.epu.gov.my/pdf/strategy-paper/.

Several reasons have been attributed to the low supply of meat for local food consumption, and among the reasons include the following[13]:

- Low productivity due to low skill-levels and utilisation of technology;
- Low quality of breeds of animals;
- High cost of animal feed;
- Lack of land area to rear livestock;
- Low levels of compliance of local farms to Malaysian Goods Agricultural Practice (MyGAP) - and the percentage of accredited firms in the livestock industry was 59%;
- Weak marketing and distribution networks resulting in dependence on various intermediaries;
- Uncoordinated institutional set-up such as overlapping functions and lack of strategic focus;
- Low levels of R&D among firms; and
- Weak interaction between research centres and industry.

The livestock industry is important in ensuring the food security of the country. This can only be ensured if the industry is able to become more knowledge intensive and move up the innovation value chain. As the industry builds its knowledge content, the potential of the industry in meeting the local demand will be high, and some of the sub-sectors will become regionally and globally competitive.

In this chapter, we examine the knowledge ecosystem of the livestock industry using the MYKE-III knowledge ecosystem model for a sample of 66 firms operating in Malaysia. From the sample, 28 are large firms, 38 are micro-SMEs, 62 local and 4 foreign firms. In the sample, the data covers all the following sub-industries: raising cattle, buffaloes, swine, pigs, poultry and other animals.

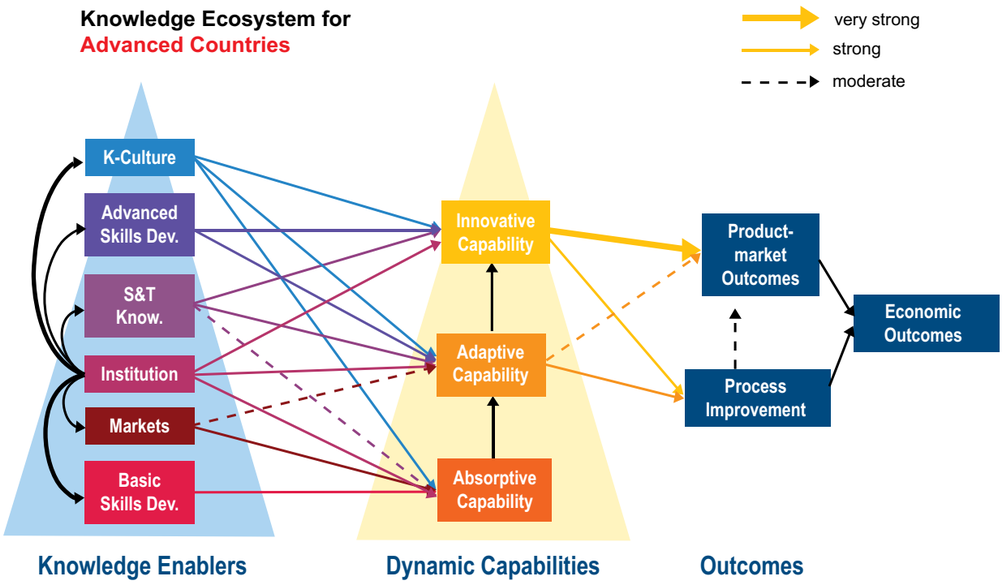
The chapter is organised as follows: In Section 6.1, a brief description of a knowledge ecosystem of the livestock industry in an advanced country is provided. In Section 6.2, we examine the knowledge ecosystem for the Malaysian livestock industry. In Section 6.3, key strengths and gaps in the Malaysian livestock ecosystem are discussed. In Section 6.4, the essay provides recommendations to improve the knowledge ecosystem of the Malaysian livestock industry before concluding in Section 6.5

6.1 Knowledge Ecosystem for the Livestock Industry in an Advanced Country

Cattle, buffaloes, swine, pigs, poultry and other animals are important sources of protein for most developed countries. In most of these countries, the livestock ecosystems are highly developed, knowledge intensive and globally competitive. Among the advanced countries that have become global livestock suppliers are European Union, Australia, Canada, New Zealand and USA. The knowledge ecosystem of the livestock industries in these countries is captured in Figure 6.1. A key feature of the ecosystem is that knowledge enablers are highly developed and contribute to the development of dynamic capabilities of the industry, leading to high levels of process improvement and product development. For many of these countries, the strong ecosystem enabled the industry to be a major contributor to national wealth.

[13]Sources: Economic Planning Unit. (2015). Strategy Paper 20, Prime Minister's Department. Retrieved from http://rmk11.epu.gov.my/pdf/strategy-paper/ and Fadhilah, A.H.H. (2015). Strategies to Strengthen Livestock Industry in Malaysia. Retrieved from http://ap.fftc.agnet.org/ap_db.php?id=477&print=1

Figure 6.1: Complex Relationships in the Livestock Industry in an Advanced Country



Knowledge intensity of the livestock ecosystems in most of the developed countries are attributed to a number of factors and they are outlined below.

- *Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the livestock industry* – to stay globally competitive, livestock industries in these countries have aligned their policies to meet the various global best practices and standards (environmental, animal welfare, labour laws, food safety and biodiversity stewardship). In this context, these countries have adopted an institutional governance structure that takes a focused approach in creating a 'holistic' knowledge ecosystem that uses the adherence to global best practices and standards as means of global competitive and comparative advantage. *Best Practice 6.1: Making Dairy Farming Work for Everyone: Strategy for Sustainable Dairy Farming*.

- *Enhance the Knowledge Institutional System of the Livestock Industry* – most of the countries have very strong institutional set up, where an agency or ministry is responsible for providing oversight to the development of the industry. The role of the agency or ministry includes leading, regulating and creating an enabling environment for industry to continuously enhance their dynamic capabilities. The development of the ecosystem is aligned to ensure the following: sustainable economic development; adherence to global best practices (food safety, environmental standards and others); leadership in biosecurity (prevention of harmful diseases and pests); increase market and global footprint; and to enhance the richness of products and services through R&D and innovation. *Best Practice 6.2: The Ministry for Primary Industries, New Zealand and DairyNZ.*

- *Develop the Knowledge Capital of the Livestock Industry* – in most advanced countries, there are significant resources channelled to increase education and training of the workforce in the livestock industry. Education is segmented into three categories:
  - Educational programs targeting school children on the importance of the livestock industry to national development – interest in the livestock industry is cultivated at a very early stage of their education as a preferred career option;
  - Training programs, especially vocational training that up skill the farming community on latest developments, certification of the qualifications and upgrading their skills set, enhancing their productivity and creating a promising career in the livestock industry;
  - University and research programs that provide education and training in key areas that are strategic to the development of the industry – increase innovation and discoveries that will enhance the competitiveness of the industry;
  - The programs are clearly mapped out to provide a career path to workers in the livestock industry.

  Best Practice 6.3: A Comprehensive Education and Training Program for the Livestock Industry in New Zealand

- *Develop the Knowledge Competency for the Livestock Industry* – major scientific breakthrough and innovations in the livestock industry have resulted in major changes to the livestock industry over the last two decades. Dedicated agencies have been established to monitor the skillsets, education and qualifications in the industry to ensure the workforce meets the changing landscape of the industry. National qualification agencies, in partnership with industry associations and educational institutions, are continuously refining and making changes to the curriculums to ensure the competencies of the workers keep pace with global technology trend, global regulatory requirements and consumer preferences. *Best Practice 6.4: New Zealand Qualifications Framework (NZQF)*

- *Facilitate Knowledge Learning & Transfer within the Livestock Industry* – various education institutions and research centres of excellence have been established in these advanced countries to provide appropriate manpower and research training that will lead to new process improvement, product development and spawn new businesses in the industry. Best Practice 6.5: AgriOne, New Zealand and Centre of Excellence in Farm Business Management – Lincoln University and Massey University.

- *Incorporate an Innovative Knowledge Approach within the Livestock Industry* – in most advanced countries, both basic and applied research are strong. To get better return on investment of R&D, researchers and industry work together to resolve some of the challenges faced by the industry. Funding and other incentives have been allocated to enable firms to seamlessly integrate new innovations, technology and expertise from multiple areas of specialisations from various centres of excellence. The use of the Fraunhofer philosophy, LEAN thinking and Industry4.0 framework are increasingly incorporated in livestock farms to increase operational efficiency and dynamic capabilities. These new approaches also open new revenue channels for firms in the form of IPs/patents licensing and technology and services provided to the industry. *Best Practice 6.6: Use of Lean Principles and Tools in the NZ Dairy Farms.*

- *The Ecosystem has very Strong Knowledge Leverage within the Livestock Industry* –in most advanced countries, government agencies, universities, centres of excellence and industry associations within the livestock industry work in partnership to be resource centres (digital forums, "one-stop-shop", help-kiosk) that provide rich content that are relevant to various stakeholders in the industry.

  Best Practice 6.7: Dariynz – Important Knowledge and Information Resource for the Livestock Industry.

Example of best practices of the above is given in ***Case-Study 6.1: The New Zealand Livestock Industry.***

6.2 Knowledge Ecosystem of the Malaysian Livestock Industry

A brief description of the knowledge ecosystem for the Malaysian livestock industry is discussed in this section of the chapter. Figure 6.2 shows the state of development of the knowledge enablers for the livestock industry. Three of the knowledge enablers (institutions, market intelligence and S&T knowledge) are very low (below 0.4); while of the remaining enablers (basic skills, advanced skills and k-culture) are performing at the moderate level, above 0.5.

Dynamic capability for the livestock industry is shown in Figure 6.3. The figure shows that the dynamic capability, process improvement and product development enablers for advanced countries were found to be significantly higher than that of the Malaysian livestock industry. The figure also shows that the absorptive capability for local firms were higher than that of foreign firms. On the other hand, adaptive and innovative capabilities of foreign firms were higher than that of local firms. Large firms were found to have higher absorptive, adaptive and innovative capabilities than micro-SMEs. In terms of process improvement, local firms registered a higher score than foreign firms while for product development, the trend was reversed. Process improvement and product development for large and micro-SMEs were found to be the same.

Figure 6.2: Knowledge Enablers for the Livestock Industry

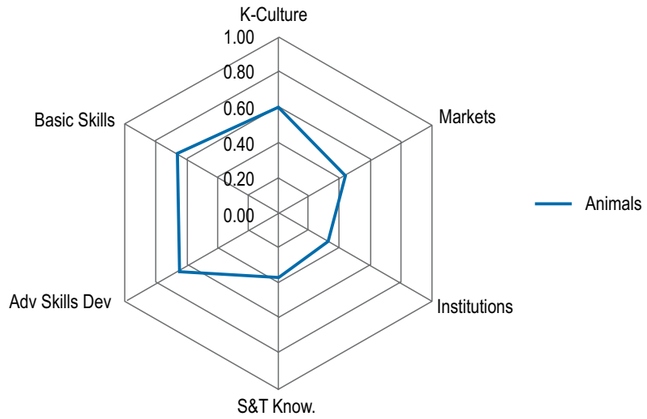
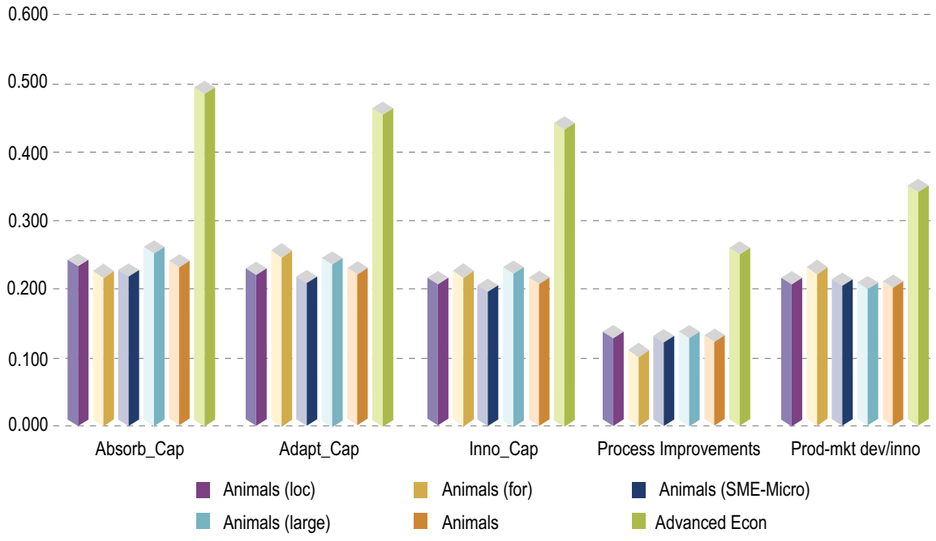
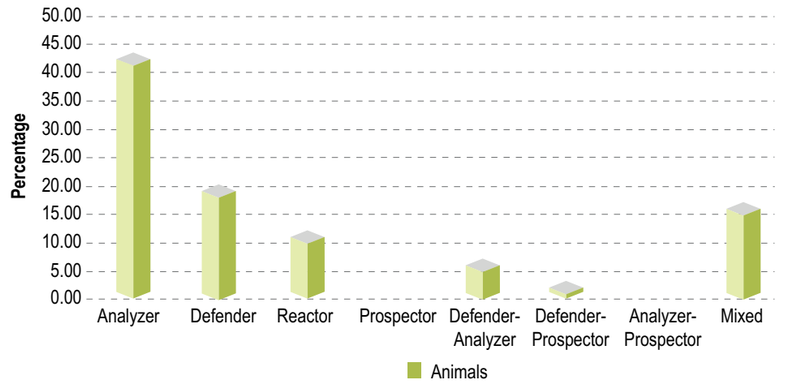


Figure 6.3: Dynamic Capabilities of the Livestock Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

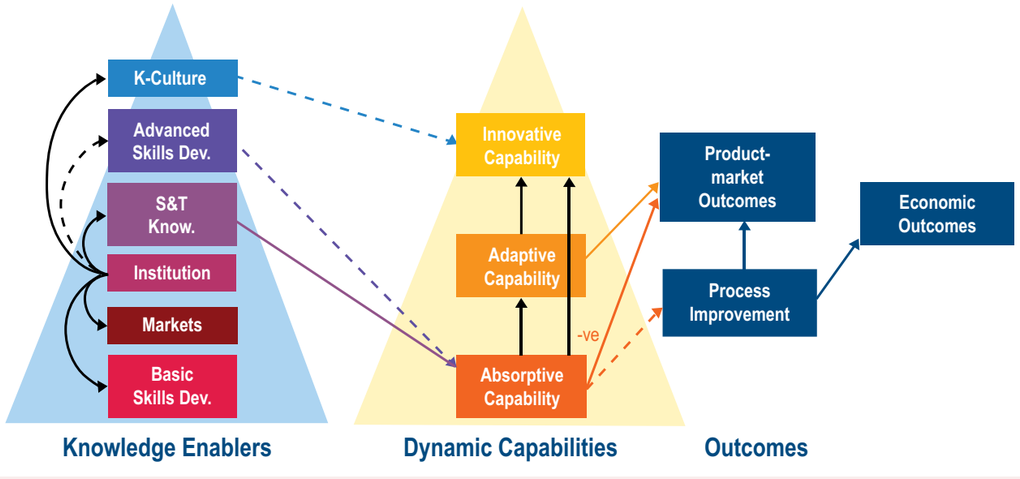
Figure 6.4: Strategic Posture of the Firms in the Malaysian Livestock Industry



Strategic postures of firms in the livestock industry are shown in Figure 6.4. The figure shows that the percentage of Analyser firms in this industry is 43%, Defender is 20%, Reactor is 12%, and Defender-Analyser is 6%. There are no prospector firms in the livestock industry. Approximately 17% of the firms pursue mixed strategies. The analysis suggests that the industry is not at the frontier of development and a majority the firms are pursuing strategies that are reactive and inward looking.

The knowledge ecosystem for the Malaysian livestock industry is shown in Figure 6.5. The figure shows that the Malaysian livestock ecosystem is significantly weaker than that of advanced countries. Within the Malaysian ecosystem, institutions have a significant impact on the knowledge enablers but do not impact the dynamic capability components directly. The impacts of the institution on advanced skills development were found to be only moderate. The only enablers that impact the dynamic capability components are S&T knowledge, which impact absorptive capability; advanced skills have a moderate impact on development adaptive capability; and knowledge culture has a moderate impact on innovative capability.

Figure 6.5: Knowledge Ecosystem of the Livestock Industry



The model also shows that firms who develop absorptive capabilities tend to develop adaptive capabilities as well; and at times try to innovate without developing adaptive capability. There are some firms that move on to develop their innovative capability after developing their adaptive capability. However, one of the weaknesses in the ecosystem is that it does not translate the innovation undertaken by firms into product market outcomes. Firms that attempt to achieve product market outcomes with absorptive capability tend to have negative product market outcomes. Given the lack of sound technology and farm management practices, the products may not be of high quality. Only firms that have built adequate levels of adaptive capability are able to achieve positive product market outcomes which still do not lead to significant economic outcomes. The latter is due to the products from local farms not deriving high value compared to competing products from foreign markets.

In summary, weaknesses in the local livestock ecosystem are leading to lower levels of dynamic capabilities and knowledge content. As a result, the firms are operating at the lower end of the value chain, producing meat products that compete on price and not quality. Weaknesses in the ecosystem hinder the industry from pursuing economies of scale, rendering them unable to meet the needs of local market.

6.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Livestock Industry

The discussion in the previous section shows that the knowledge ecosystem for the livestock industry has some strengths and weaknesses that are discussed below.

Key Strengths of the Livestock Ecosystem:

- The livestock industry is an important industry for ensuring the food security of the country. Hence it received strong support from the Malaysian government under the 11th Malaysia Plan, which include support of the following:
  - Increasing R&D funding for genetic enhancement and breeding techniques to improve the quality of meat production and reduce cost of production;
  - Increasing the quality of animal feed;
  - Upgrading animal milk production facilities; and
  - Use of radio frequency traceability technology and techniques to monitor animal movement and disease control.
- The livestock industry was also identified as Entry Point Projects (EPPs), which include swiftlet nests, cattle rearing in palm oil plantation, strengthening major anchor firms in cattle feedlots, establishing strong dairy cluster through partnership with large dairy company, and investing in foreign cattle operation. The EPPs were envisaged to increase the nation's Gross National Income (GNI) of RM28.9 billion by 2020.
- Continued investment in three strong research institutes (MARDI, University Pertanian Malaysia and University Malaya) that are undertaking important R&D activities relevant to the local livestock.

Key Gaps in the Livestock Industry Ecosystem:

There have been a significant number of initiatives undertaken by the government to enhance the knowledge intensity of the industry. However, there are numerous gaps in the ecosystem that hinder its dynamic capability and ability to be a major player in the region. The gaps in the ecosystem are discussed below.

- The institutions in the livestock industry have no impact on the dynamic capability components. Hence, the levels of knowledge content are low and the contribution of knowledge to wealth creation in this industry is low. The reason for these results is because institutions do not work closely to develop, implement and monitor progress as a team. Key agencies such as government agencies and industry associations do not have adequate technical capability and adequate resources to develop such capabilities.
- There is a lack of cohesive and holistic management of talent for this industry. Many youths prefer building their careers in other industries, which provide more attractive career options. There is also a lack of funding and support for unskilled workers to scale up their education and certification. The problem is further exacerbated by the lack of access to good training and R&D facilities for the firms, especially for micro-SMEs.
- There has been adequate investment in R&D and training. However, the impact to the livestock community, especially to SMEs, was low due to weak cooperation between universities, GRIs and industry.
- The industry remains labour intensive and low-tech, while many of the farms are kept in poor condition.
- Most firms in this industry, especially micro-SMEs, are not sophisticated in the use of new technology and hence do not use their networks optimally for market intelligence to build dynamic capability. Many firms are dependent on government agencies and "middle-men" for information and support. The latter tends to lead to exploitation of the self-same firms and workers by the "middle-men".

6.4 Recommendations to Improve the Malaysian Livestock Ecosystem

The development of the livestock industry and its move towards becoming a knowledge intensive industry is important for the industry to meet the domestic and regional demand for meat consumption. To ensure that the industry builds knowledge content and becomes regionally competitive, the following recommendations are proposed.

Recommendation 6.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) within the Livestock Industry

Competitiveness of the livestock industry globally is determined by a number of factors and among them includes the ability of firms to meet global best practices and benchmark standards pertaining to animal farming, processing, storing and selling. In this context, the global standards cover a wide range of issues such as environment, health, food safety, animal welfare, biosecurity and labour. Meeting these global standards and best practices, which is increasingly becoming a source of competitive and comparative advantage for countries, the local livestock industry will be required to increase investment in talent

development, infrastructure, technology, governance systems, monitoring, surveillance and other support systems. The global best practices and standard must be core to curriculum in all training, education and research programs undertaken for the livestock industry.

Best Practice 6.1: Making Dairy Farming Work for Everyone: Strategy for Sustainable Dairy Farming.

Recommendation 6.2: Enhance the Knowledge Institutional System of the Livestock Industry

- To ensure the industry enhances its knowledge content, there needs a more effective institutions, led by the Ministry of Agriculture, jointly with industry associations, key government agencies, GRIs and universities, to develop a strategic plan underpinned by sound scientific evidence for the livestock industry.

- The plan should give focus on the following: identifying key focus areas of development with clear targets and tangible outcomes; and improving organisation set-up and governance, including information flow and knowledge sharing between government agencies, industry associations, GRIs and educational institutions.

Best Practice 6.2: The Ministry for Primary Industries, New Zealand and DairyNZ

Recommendation 6.3: Develop the Knowledge Capital of the Livestock Industry

- To raise the level of knowledge content of the industry, professionalising the work in the livestock industry is critical. This is done by ensuring there are adequate training programs, certificate course and higher level qualifications which are made affordable and accessible to workers in the industry.

- The training and educational programs should be jointly developed with industry, so as to ensure that they meet the needs of the industry. To ensure the relevance of these programs, a strong feature of these programs must include internships and work placement training. These capability development programs and courses should map clear career pathways within the industry.

- Design educational programs for school children on the importance of the livestock industry to national development so as to cultivate interest among the youth on careers in the livestock.

Best Practice 6.3: A Comprehensive Education and Training Program for the Livestock Industry in New Zealand

Recommendation 6.4: Develop the Knowledge Competency of the Livestock Industry

- The livestock industry should give greater priority in developing core competencies, skills standards and qualifications, covering a wide range of jobs within the industry:
  - *Livestock sector competency* – animal handlers, managers of animal farms, business managers and animal transporters;
  - *Meat processing, packaging, sales and distribution* – process workers, meat retailers, wholesalers, importers and exporters;
  - *Livestock and meat (food) compliance sector* – compliance officer, supervisors, managers, animal welfare officer, disease control officer, and halal certification specialist;
  - *Environmental Management Systems sector* – officers, supervisor and managers that provide oversight to environment, food safety and quality, occupational health and safety;
  - *Business services* - financial specialist, public relations, legal, marketing & branding; and
  - *Innovations and Technology* – scientists, researchers and technologist.

- A robust mechanism is in place to continuously review the core competencies so as to ensure that the industry keeps pace with the global trends, technological shifts, changes in standards and compliance.

Best Practice 6.4: New Zealand Qualifications Framework (NZQF)

Recommendation 6.5: Facilitate Knowledge Learning and Transfer within the Livestock Industry

- The livestock industry should focus its R&D activities on key priority areas where the industry faces challenges and areas the industry would like to build competitive advantage.

- Strengthen existing CoEs and universities in the livestock industry – fostering a strong translational research focus for the benefits of the industry. This includes developing areas such as innovative animal breeding methods, new animal farm-based technology and applications, management systems, logistic supply chains, financial models, marketing and branding.

- Funding should be given to CoEs and universities to assist industry, especially micro-SMEs, to gain access to expertise, research facilities, technology and other support systems to enhance their business operations, modelled after the AgroOne and New Zealand and Centre of Excellence in Farm Business Management – Lincoln University and Massey University.

Best Practice 6.5: AgriOne, New Zealand and Centre of Excellence in Farm Business Management – Lincoln University and Massey University

Recommendation 6.6: Incorporate an Innovative Knowledge Approach within the Livestock Industry

- The centres of excellence (CoEs) and institutes in the livestock should incorporate the "Fraunhofer" philosophy, LEAN-Principles and Industry4.0 to enhance efficiency and effectiveness of R&D programs in meeting the needs of the livestock industry (improvement process improvement and product development); at the same time increase new revenue streams through technology/ knowledge transfer, commercialisation of IPs/ patents, IP/patent licensing, management services, workshops trainings and consultancy

Best Practice 6.6: Use of Lean Principles and Tools in the NZ Dairy Farms.

Recommendation 6.7: Strengthen the Knowledge Leverage within the Livestock Industry

- Strengthen existing CoEs, universities and industry associations as important knowledge and resource centres for the industry. These resource centres strengthen knowledge leverage within the industry, providing information on research expertise in Malaysia and overseas; trainings, workshops and conference; new science and technology discoveries; financing opportunities and grants and other services that enhance farm management and business development.

Best Practice 6.7: Dariynz – Important Knowledge and Information Resource for the Livestock Industry

6.5 Conclusion

In this chapter, the knowledge ecosystem of the livestock industry was measured using a novel knowledge ecosystem model. The new framework was able to identify some of the key strengths and gaps in the current livestock ecosystem. Key policy recommendations were provided to strengthen the ecosystem so as to enable the firms to build absorptive, adaptive and innovative capability. Improving the dynamic capability components will enhance the potential of the industry to increase process improvement and product development, thus raising the competitiveness and sustainability of the industry. A more knowledge intensive livestock industry will also be able to meet the domestic demand for meat and cater for increasing demand for meat in the region.

Appendix for Chapter 6

Case-Study 6.1: Sustainable Dairy Farming in New Zealand

The New Zealand (NZ) dairy farming industry is the world's largest exporter of dairy ingredients, which comprise one third of market share. The NZ dairy industry produces for 165 million population, with over NZ$13 billion in exports in 2012, and close to NZ$5 billion to the gross domestic product of the nation.[14] Only 5% of dairy products produced in New Zealand are for the domestic market; the remaining are for global export market[15]. The industry has come under intense competition from low cost producers and an economically volatile and challenging environment. To address some of the challenges, the NZ dairy farming industry has undertaken a focused approach to develop the industry to be resilient to competition and uncertain market conditions.

Best Practice 6.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) within the Dairy Industry

The New Zealand government in partnership with industry associations have addressed the competitiveness of the dairy farming industry by realigning the strategies to strengthen the dairy ecosystem to achieve the following:

- Increase profitability of farming community by transforming the industry to be knowledge intensive using state of the art scientific knowledge and technological developments;
- Invest in creative talent that will develop innovative solutions to enhance the productivity of the industry;
- Raise international competitiveness of the industry through adherence to global best practices and standards;
- Brand and promote the NZ industry as a leading provider of high quality products through stewardship of sustainable development practices; and
- Ensure strong government-industry partnership to address the challenges encountered by the farming community and enable them to be global players.

These key performance indicators are regularly reviewed and strategies are continuously refined to ensure the industry is at the forefront of development and market leadership. For more information on the plans, refer to: DariyNZ (2013) and DariyNZ. (2009).

Best Practice 6.2: Enhance the Knowledge Institutional System of the Dairy Industry

The Ministry for Primary Industries is in partnership with several industry associations such as DairyNZ, Federated Farmers Industry Group, Dairy Association of New Zealand (DCANZ) and Dairy Womens' Network to work closely to provide stewardship and direction for the industry. They do so by building knowledge content to enhance global competitiveness in a responsible and sustainable way. This is done by regular consultations and developing a 'holistic' strategic plan for the industry to address the following:

- Raise global competitiveness of the industry through enhancing the productivity of the farms; investing in the right R&D, scientific knowledge and technology to solve the challenges of the industry; invest in the right talent for the industry; ensuring biosecurity and product integrity of the industry; investing in information and knowledge management systems that be source of raising the dynamic capability of the industry.
- Ensure that responsible and sustainable practices are adhered to, including adherence to global best practices and standards pertaining to environment, animal welfare, work quality, the well-being of communities and the prosperity of the nation.

Best Practice 6.3: Develop the Knowledge Capital of the Dairy Industry

The industry maintains its high knowledge capital by ensuring that the manpower training in the industry keeps pace with scientific and technological developments. A comprehensive skills development program is in place that provides short course and formal certifications and qualifications for a wide range of workforce in the dairy and livestock industry. These programs are jointly designed with industry and has strong component of experiential learning through internship and work placement programs. The Primary Industry Training Office (ITO), the largest training office in New Zealand provides training and qualifications in all fields of dairy farming, covering dairy breed, health, husbandry, feeding and pastures. The ITO also provides training in managing farms, production management and a diploma in agribusiness management. For more information, please refer to: PrimaryITO (2016).

Best Practice 6.4: Develop the Knowledge Competency of the Dairy Industry

The knowledge competency of dairy industry is being transformed by the various scientific and technological developments, including new information and management systems. To ensure that the dairy industry is keeping pace with global developments, the New Zealand Qualification Agency constantly monitors the changing knowledge competency requirements of the industry and works closely with industry associations as well as education and training institutions to upgrade its knowledge requirements for the workforce. A comprehensive governance mechanism is in place to continuously review the core knowledge competencies required by the workforce. For more details, refer to: New Zealand Qualifications Authority [NZQA] (2016).

Best Practice 6.5: Facilitate Knowledge Learning and Transfer within the Dairy Industry

To foster strong translational R&D that benefits the industry, a company called AgriOne was established by two universities in New Zealand (Lincoln and Massey Universities) in 2012. The company works closely with the Centre of Excellence in Farm Business Management (CoE-FBM) on transforming the dairy value chain into a more knowledge-intensive and efficient global supply chain. The research and education projects are funded by major players such as DairyNZ and Fonterra. A wide range of R&D and education programs -undertaken through the CoE-FBM in areas that are strategic to the development of firms in the dairy industry- include the following: developing strategy and structures for improving operational efficiency; developing resilience and effective decision-making; innovative farms systems, big-data analytics and developing talent for the farming industry. The centre also offers courses that are relevant to the farming communities in New Zealand. AgriOne and the CoE-FBM also develops new software, cloud technology, financial tools and other farm management technology that are tested and widely used by the farming communities. They are also important sources of information and knowledge for the community. The online portals are rich in content and user-friendly. For more information, refer to: AgriOne (2016a) and AgriOne (2016b).

[14]Source: DariyNZ. (2013). Making Dairy Farming Work for Everyone: Strategy for Sustainable Development Farming, 2013-2020, DairyNZ, Hamilton, NZ. Retrieved from https://www.dairynz.co.nz/media/209786/strategy-for-sustainable-dairy-farming.pdf

[15]Source: DariyNZ. (2013). Making Dairy Farming Work for Everyone: Strategy for Sustainable Development Farming, 2013-2020, DairyNZ, Hamilton, NZ. Retrieved from https://www.dairynz.co.nz/media/209786/strategy-for-sustainable-dairy-farming.pdf

Best Practice 6.6: Incorporate an Innovative Knowledge Approach within the Dairy Industry

Dairy farms in NZ use Lean-Principles extensively to create a culture of reduced wastage, improve the flow of information and knowledge across all stakeholders, increase the value proposition for consumers and instil a culture of continuous improvement. Among the Lean tools used are "Waste Hunt', which identify wastes as a result of weak knowledge enablers in the dairy farm system. The incorporation of the Lean principles and tools assists farms in achieving the following:

- Reduce waiting time from one process to the next so as to ensure the freshness of the milk and dairy products;
- Minimize oversupply of milk and dairy products – incorporate a 'Just in Time" approach, thus reduce unnecessary inventory cost and stabilise price of milk and dairy products;
- Improve transportation and logistics supply chain - shorten delivery time, reduce wastage, damage and animal discomfort;
- Reduce defects, downgrading of quality due to inferior feed, livestock injury and diseases.

Example lean-thing in Synlatt Farms Ltd, Cantebury, refer to: DariyNZ Farmers' Forum (2016).

Best Practice 6.7: Strengthen the Knowledge Leverage within the Dairy Industry

DairyNZ is an industry organisation, representing all the dairy farmers in New Zealand. The entity not only invests in developing practical on-farm technology, tool, scientific knowledge, but it is also an important resource centre for the farming community. It also plays an important advocacy role to ensure that the farming community gets holistic support to develop the knowledge enablers of the ecosystem. This includes ensuring the following:

- Availability of adequate financing;
- Appropriate R&D activities are undertaken for the respective communities located across the country;
- Relevant educational and training programs for all segments of the farming communities;
- Adherence to global best practices and standards;
- Inclusive farm development strategies and policies to ensure farmers have a profitable, sustainable and competitive future; and
- Strengthen existing CoEs, universities and industry associations as important knowledge and resource centres for the industry. These resource centres strengthen knowledge leverage within the industry, providing information on research expertise in Malaysia and overseas; trainings, workshops and conference; new science and technology discoveries; financing opportunities and grants and other services that enhance farm management and business development.

DairyNZ is an excellent "one-stop platform" for the farm community in New Zealand to acquire information, knowledge, expertise, technology, policy analysis and other resources that will ensure the industry moves up the innovation value chain and continues to be sustainable and globally competitive. For more information, refer to: DariyNZ (2016).

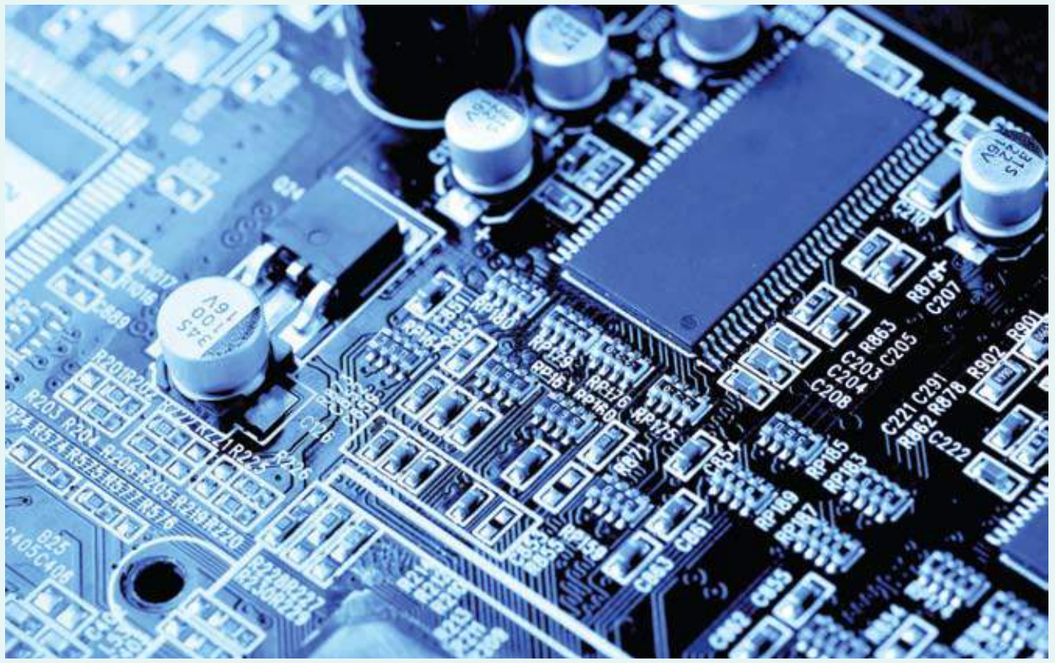
References:

1. AgriOne. (2016a). *Home*. Retrieved from http://www.onefarm.ac.nz
2. AgriOne. (2016b). *Centre of Excellence in Farm Business Management.* Retrieved from http://www.onefarm.ac.nz/content/centre-excellence-farm-business-management
3. DariyNZ. (2009). *Strategy for New Zealand Dairy Farming 2009/2020*. DairyNZ, Dairy Companies Association of New Zealand (DCANZ) and Federated Farmers, NZ. Retrieved from http://www.naut.is/Files/Skra_0041910.pdf
4. DariyNZ. (2013). *Making Dairy Farming Work for Everyone: Strategy for Sustainable Development Farming, 2013-2020,* DairyNZ, Hamilton, NZ. Retrieved from https://www.dairynz.co.nz/media/209786/strategy-for-sustainable-dairy-farming.pdf
5. DariyNZ. (2016). *Home.* Retrieved from https://www.dairynz.co.nz/
6. DariyNZ Farmers' Forum. (2016). *InSynC: Lean Thinking Principles.* Retrieved from www.dairynz.co.nz/media/621424/lean_synlait_farms.pdf
7. New Zealand Qualifications Authority [NZQA]. (2016). *Domain - Dairy Farming*. Retrieved from http://www.nzqa.govt.nz/framework/explore/domain.do?frameworkId=75421
8. PrimaryITO. (2016). *Home.* Retrieved from https://primaryito.ac.nz

CHAPTER 7

KNOWLEDGE CONTENT OF THE MALAYSIAN ELECTRICAL & ELECTRONIC (E&E) COMPONENTS ECOSYSTEM

CHAPTER 7
Knowledge Content of the Malaysian Electrical & Electronic (E&E) Components Ecosystem



7.0 Introduction

The knowledge ecosystem for the Malaysian E&E (components) industry is examined in this chapter. This industry is an important driver for the Malaysian economy, where the industry contributed RM5.8 billion of investments in 2014.[16] Several large multinational companies (MNCs) have invested significant resources to develop the local semiconductor industry. These MNCs include Intel, AMD, Freescale Semiconductor, ASE, Infineon, STMicroelectronics, Texas Instruments, Renesas. There exists a number of major local players that have contributed to the development of this industry, and they include Silterra, Globetronics, Unisem and Inari.

While the E&E (components) industry has been an important contributor to the Malaysian economy since the 1980s, the share of Malaysia's exports are on a downward trend due to intense competition from other countries such as China, India and Vietnam[17]. These economies have a larger pool of workers, which enables them to pursue better economies of scale than Malaysia. To raise the competitiveness of the E&E (components) industry, the key enablers of the E&E (components) knowledge ecosystem should be strengthened to ensure that the industry is able to enhance its absorptive, adaptive and innovative capabilities.

[16]Source: MIDA, downloaded from http://www.mida.gov.my/home/electrical-and-electronic/posts/, accessed, 17 November, 2016.

[17]Economic Planning Unit. (2015). Strategy Paper 19, Prime Minister's Department. Retrieved from http://rmk11.epu.gov.my/pdf/strategy-paper/.

In this chapter, we examine the knowledge ecosystems of the E&E (components) industry using the MYKE-III knowledge ecosystem model for a sample of 242 firms operating in Malaysia. From the sample, 140 are large firms, 102 are micro-SMEs, 108 are local and 134 foreign firms. The E&E (components) industry consists of the following sub-industries: electronic components and boards; magnetic and optical media; electric motors, generators, transformers and electricity distribution and control apparatus, batteries and accumulators; fibre optic cables; fibre optic cables; manufacture of other electronics and electric wires and cables; and wiring devices.

The chapter is organized as follows: In Section 7.1, a description of a knowledge ecosystem of the E&E (components) industry in an advanced country is provided. In Section 7.2, we study a description of the knowledge ecosystem for the Malaysian E&E (components). In Section 7.3, the key strengths and gaps in the Malaysian E&E (components) ecosystem are discussed. In Section 7.4, the essay provides key recommendations to improve the knowledge ecosystem of the Malaysian E&E (components) industry before concluding in Section 4.5.

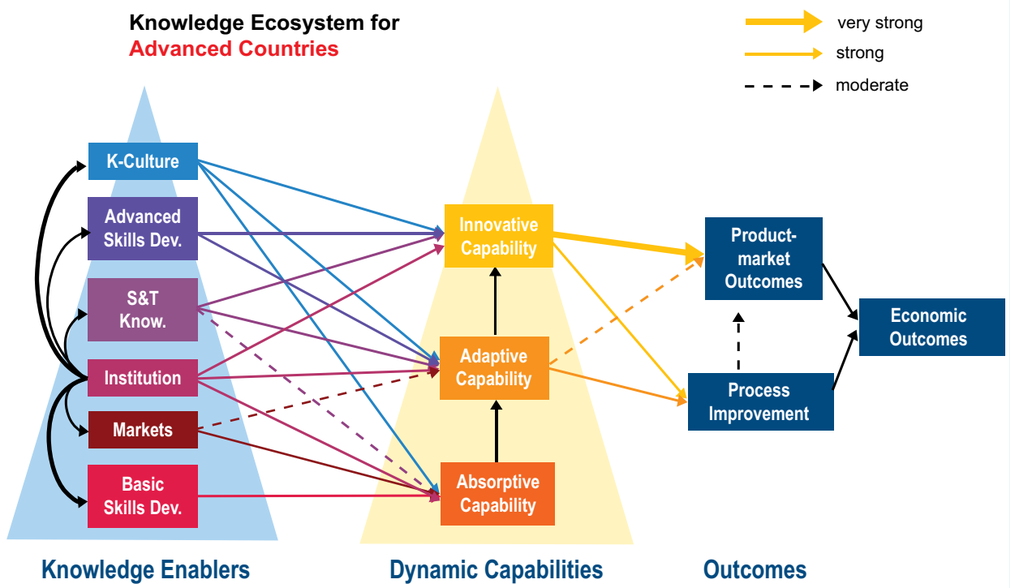
7.1 Knowledge Ecosystem for the E&E (Components) Industry in an Advanced Country

The knowledge ecosystem for the E&E (components) is shown in Figure 7.1. The figure shows the knowledge enablers have a strong impact on all three dynamic capability components. The dynamic capability components translate to both process improvement and product market development. Both the process improvement and product market development contribute to economic outcomes for the industry, in the form of higher economic wealth.

The strong knowledge ecosystem for the E&E (components) is attributed to a number of factors, which are discussed below.

- *Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the E&E (components) industry* – convergence technological platforms is fostering greater integration of cyber-physical systems, which enable virtual and physical systems to provide a networked environment that enable intelligent devices to interact and

Figure 7.1: Complex Relationships in the E&E (Components) in an Advanced Country



communicate with each other – a truly embedded system with the internet of things, big data and cloud technology. These global trends are powered by the high-speed electronics revolution. Countries with very strong STEM R&D are continuously investing in developing new semiconductors and electronics components that will nurture a seamlessly integrated virtual reality environment. *Best Practice 7.1: Aligning German High-Technology Innovation Strategy to global trends.*

- *Enhance the Knowledge Institutional System of the E&E (components) Industry* – the government is the orchestrator for supporting the development of the knowledge enablers such as developing a strong scientific and R&D base by providing funding for large research programs, infrastructure, industry-based CoEs, ensure appropriate talent development policies. The government also fosters strong partnership with industry associations in mapping the direction of the industry and channels resources and governance systems to ensure the industry continuously develop and are globally competitive. *Best Practice 7.2: German National Innovation Ecosystem.*

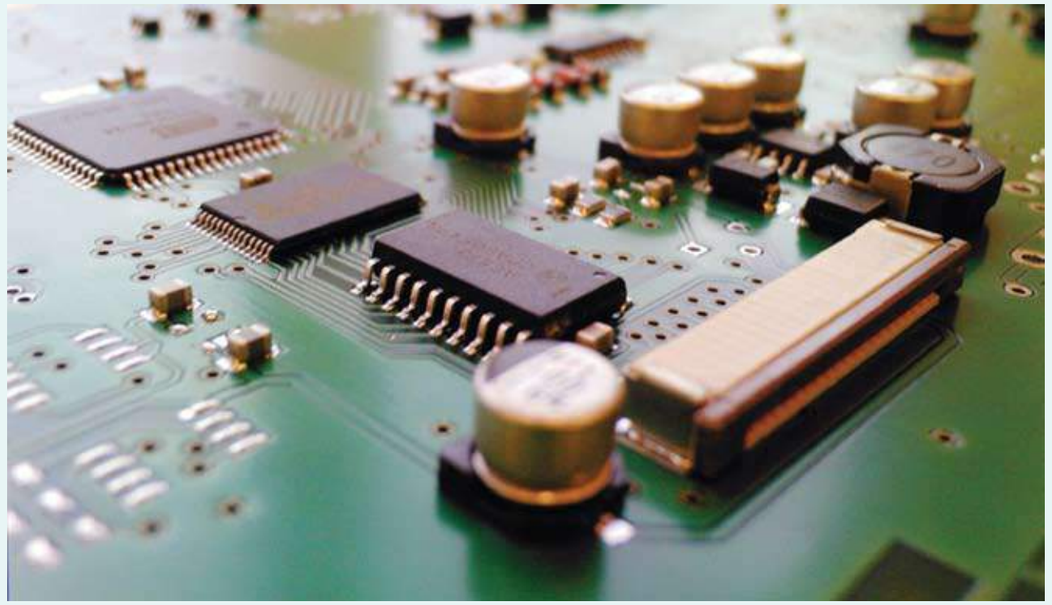
- *Incorporate an Innovative Knowledge Approach within the E&E (components) Industry* – a targeted approach in focusing R&D on key priority areas in strategic areas of development and put a systematic framework of engaging key external stakeholders (industry players) to foster translation research outcomes. This leads to new advanced technology and new applications, which spawn new industries and services. *Best Practice 7.3: Fraunhofer Framework in enhance the impact and richness and impact of R&D in Germany.*

- *Develop the Knowledge Capital of the E&E (components) Industry*– there is a strong emphasis in STEM education and TEVT educational and training programs from certificate to post-doctoral training. *Best Practice 7.4: German Technical and Vocational Education.*

- *Develop the Knowledge Competency for the E&E (components) Industry* – clear mapping of the skill set needed at all levels of education – first skill level (primary education); second skill level (lower secondary education), third level (high school), fourth (training and certification – certificate course and specialized training), fifth level (higher qualifications – tertiary qualifications), sixth level (life-long learning). The core competencies range from planning, mounting, installing, inspecting designing, constructing, modifying, developing customized design, supervising teams, configuring, and testing. A clear path from training to provisional certification and obtaining higher education and research pathways are clearly articulated by skills development framework in most advanced countries. *Best Practice 7.5: The German Technical Education Skills Development Framework of "Berufskonzept' (Occupation) and 'Dualities' (industry-educational institution cooperative endeavour).*

- *Facilitate Knowledge Learning & Transfer within the E&E (components) Industry* – a systematic framework in place for industry, especially the SMEs to gain access to cutting-edge technology, expertise, R&D and innovations from universities, GRIs and Centres of Excellence. *Best Practice 7.6: The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) – nurturing and strengthening cooperative innovative endeavours in the E&E (components) industry.*

- *The Ecosystem has very Strong Knowledge Leverage within the E&E (components) Industry* – the key institutions, such as Government and industry associations provide various platforms, forums and 'One-Stop-Centre' for industry, researchers, universities and other stakeholders gain access to expert service, research facilities, training workshop, testing and other resources that will continuously build knowledge and become a knowledge hub for the industry. *Best Practice 7.7: The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) – important knowledge resource for all stakeholders in the E&E (components) industry.*

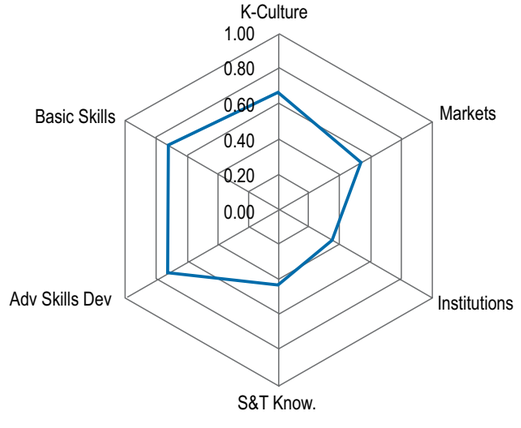


7.2 Knowledge Ecosystem of the Malaysian E&E (Components) Industry

The knowledge ecosystem for the Malaysian E&E (components) industry is discussed in this section. Figure 7.2 shows the state of development of the knowledge enablers for the E&E (components) industry. Three of the knowledge enablers (institutions and S&T knowledge) are performing below optimal level (below 0.5); while the remaining four enablers (basic skills, advanced skills, k-culture and market intelligence) are performing at the moderate level, between 0.5 and 0.8.

The dynamic capability components, process improvement and product development for the Malaysian E&E (components) industry is shown

Figure 7.2: Knowledge Enablers for the E&E (Components) Industry

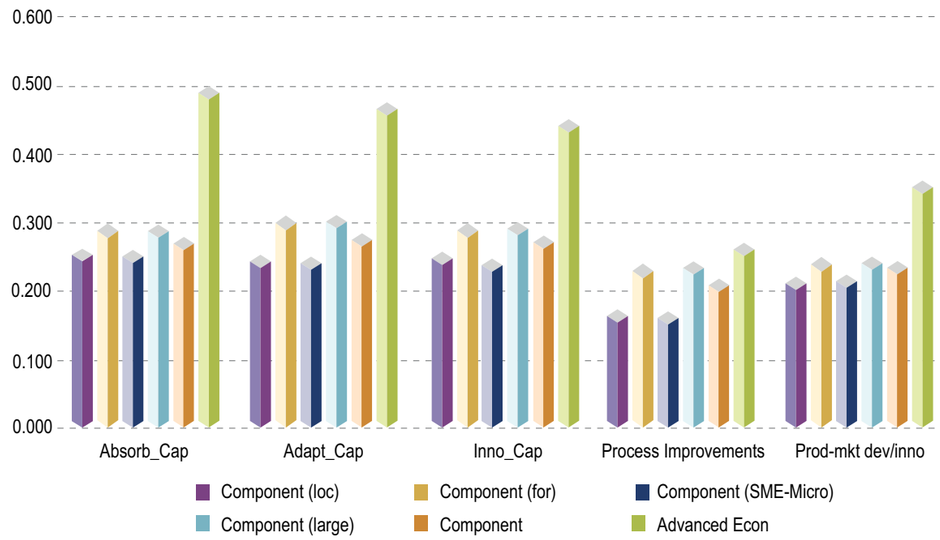


Note: If $0 \leq x < 0.5$, the enablers are weak; if $0.5 \leq x < 0.8$, the enablers are moderately developed; and if $0.8 \leq x \leq 1$, the enablers are highly developed.

in Figure 7.3. The dynamic capability, process improvement and product development for advanced countries were found to be significantly higher than that of the Malaysian E&E (components) industry. The study also found that foreign firms have significantly higher absorptive, adaptive and innovative capabilities than local firms. Similarly, larger firms were found to have higher absorptive, adaptive and innovative capabilities than micro-SMEs. The empirical analysis also shows that process improvement and product development for foreign and large firms are higher than that of local and micro-SMEs.

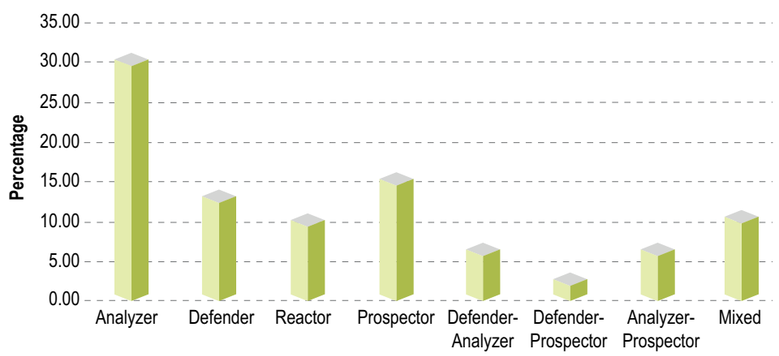
The strategic postures of firms in the Malaysian E&E (components) industry are given in Figure 7.4. The figure shows that percentage of firms based on the strategic posture are as follows: Analyser firms is 31%; Prospector firms, 16%; Defender firms, 14%; Reactor firms, 11%; Defender-Analyser at 7%, Analyser-Prospector 5% and Defender-Prospector, 4%. A significant percentage of the firms adopt a mixed strategic posture, 11%. The empirical results show that the percentage of firms (Prospectors) who invest in innovative and creative endeavours are relatively higher than other industries. This is not surprising as the number of firms with R&D centres are relatively higher than other industries.

Figure 7.3: State of the Dynamic Capabilities of the E&E (Components) Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

Figure 7.4: Strategic Posture of Firms in the Malaysian E&E (Components) Industry



The knowledge ecosystem for the E&E (components) industry is shown in Figure 7.5; which show that institutions have a significant impact on all the enablers. Institutions were also found to have a positive impact on absorptive capability. S&T knowledge, advanced skilled development and knowledge culture have a positive and significant impact on adaptive capability. Knowledge culture also has a positive impact on absorptive capability. The ecosystem also shows that firms are able to transition from absorptive capability to adaptive capability; and finally transition from adaptive capability to innovative capability. Some firms try to 'leap-frog' from absorptive to innovative capability. Unfortunately, the impact of innovative capability on process improvement and product market development were found to be statistically insignificant. The firms that are able to achieve adaptive capability were found to have a moderate impact on process improvement and product market development. Firms that are able to create process improvement are also able to create product market development. Firms that are able to create process improvement and product development are able to generate higher economic outcomes, which include an increase in productivity, profits, return of investment and market share.

The impact of knowledge enablers on dynamic capability components, process improvement, product market development and economic outcomes for large and micro-SMEs are shown in Figure 7.6. The figure shows that the impact of institutions on S&T knowledge is higher for micro-SMEs than for larger firms. Similarly, the impact of institutions on innovative capability; and impact of S&T knowledge on adaptive capability for micro-SMEs were found to be higher than that of larger firms. The impact of adaptive capability on product market improvement were found to be stronger for micro-SMEs than larger firms. The impact of innovative capability on process improvement was found to be higher for micro-SMEs than larger firms. However, the impact of innovative capability on product market outcomes was higher for larger firms than micro-SMEs.

Figure 7.5: Knowledge Ecosystem of the E&E (Components) Industry

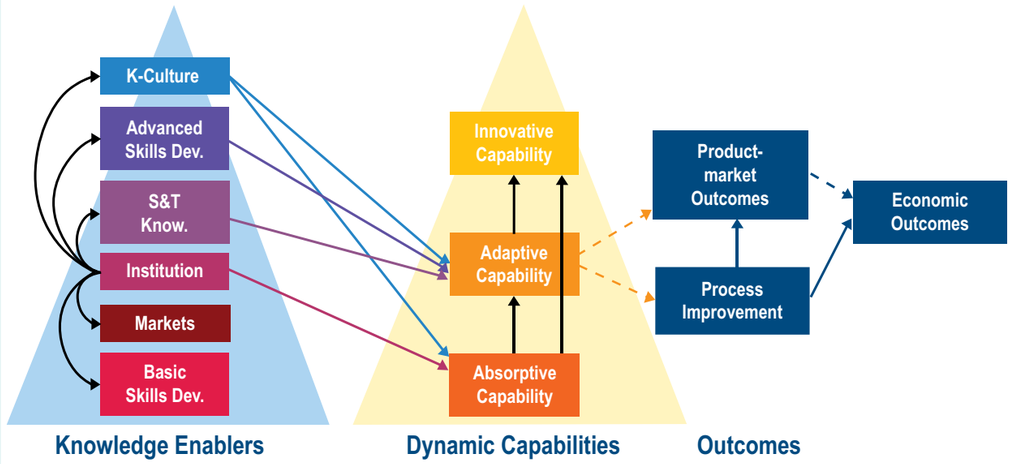
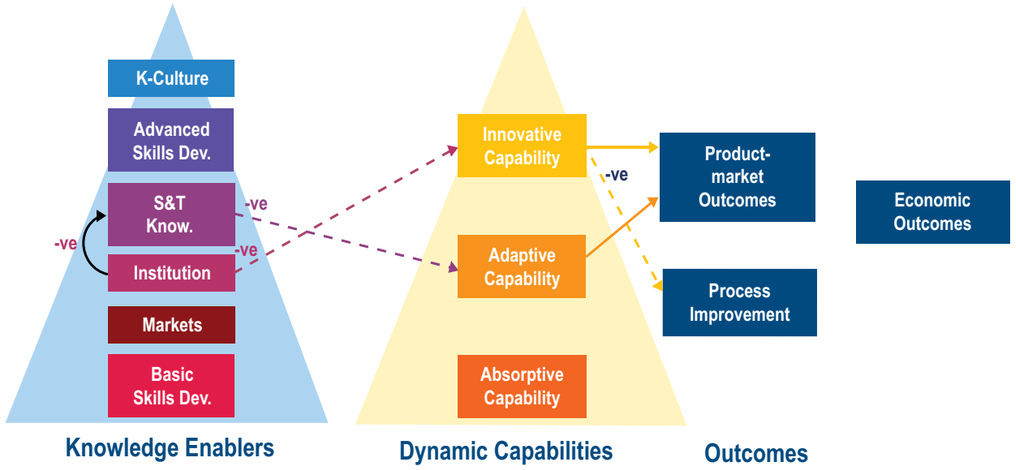


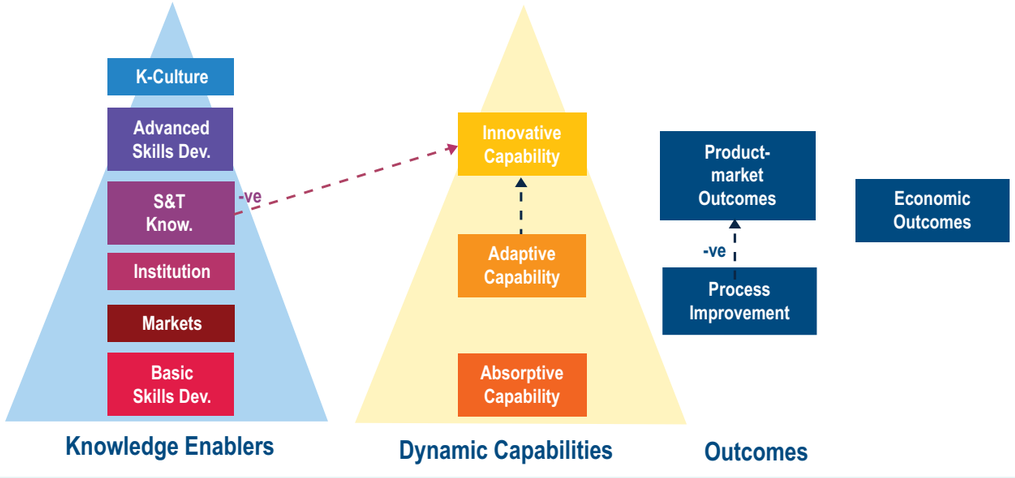
Figure 7.6 Knowledge Ecosystem for E&E (Components) Industry
(Large versus Micro-SME firms)



The impact of knowledge enablers on dynamic capability components, process improvement, product market development and economic outcomes for local and foreign firms are shown in Figure 7.7. The figure shows that the impact of S&T knowledge on innovative capability is higher for local firms than foreign firms. Local firms are also able to translate process improvement into product market development more efficiently than foreign firms. On the other hand, foreign firms are in a better position to translate adaptive capability into innovative capability.

In summary, micro-SMEs tend to benefit more than larger firms from institutional development onto innovative capability; and S&T knowledge onto adaptive capability. Further, micro-SMEs tend to generate higher product market outcomes from adaptive capability than larger firms. A similar pattern can be observed with respect to process improvement on innovative capability. On the other hand, larger firms are able to generate higher product market outcomes from innovative capability than micro-SMEs.

Figure 7.7: Knowledge Ecosystem for E&E (Components)
Foreign versus Component Local



7.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian E&E (Components) Industry

Based on the analysis of the knowledge ecosystem of the E&E (components) industry, the key strengths and gaps of the ecosystem are provided below.

Key Strengths of the E&E (Components) Ecosystem:

- This industry has received very strong support from the Malaysian government in terms of developing the appropriate technological infrastructure, education and training, fiscal and other non-fiscal incentives to attract leading MNCs to transform Malaysia into a leading global manufacturing hub for electronic components.

- This industry is an important driver for the National Key Economic Areas (NKEA) and the Entry Point Projects (EPP) in the areas of integrated circuit design, silicon production, wafer and cell production, solar modular production, LED and Solid State Lighting, wireless communication and RFID, electrical and home appliances, solar photovoltaic, embedded systems, electric vehicle manufacturing electrical and electronics component manufacturing and nanotechnology.

- To spearhead R&D in the electronics industry, Collaborative Research in Engineering Science and Technology (CREST) was established in 2012 by the Malaysian Government. CREST consists of 14 founding members, which include the Northern Corridor Implementation Authority (NCIA), Khazanah Nasional, University of Malaya (UM), and University of Science Malaysia (USM) and 10 leading E&E companies.

- Malaysia also has a number of R&D Centres of Excellence in electronics and among them include Malaysia Institute of Microelectronic Systems (MIMOS) and Scientific and Industrial Research Institute Malaysia (SIRIM) that are leading applied research in frontier research and innovation in the electronics industry.

- There are also a number of universities such as University Malaya, University Technology Malaysian, Multimedia University and others that are undertaking cutting-edge R&D in the electronics areas, which has the potential to develop new electronic components and devices.

Key Gaps E&E (Components) Ecosystem:

- The industry has developed in a rather ad-hoc way; hence the component industry is rather fragmented. The industry has not kept pace with rapid changes taking place with converging technology platforms; hence many are not well prepared. Most of the industry leaders are foreign multinational companies with strong R&D and design operations in other countries while local players largely operate at the lower end of the innovation value-chain. The local pace-setters lack the depth and breadth of R&D and production value chains.

- The industry is highly competitive, but cooperation and collaborations between all stakeholders is weak.

- The E&E (components) industry requires highly skilled technical workforce. One of the challenges in Malaysia is getting a steady quantum of quality TEVT educated workers for the industry. Further, the TEVT education lags behind the needs of a fast-changing industry, especially with respect to converging technology and knowledge platforms. The challenge of recruiting TEVT personnel in even more acute for SMEs. Due to high staff turn-over, many do not invest in training and skills development programs.

- The industry is developing rapidly due to major technological breakthroughs and to ensure firms absorb, adapt and innovate use these new innovations, they would require specialist skills, creative talent and employees with higher order thinking. Large firms are in a better position than micro-SMEs when investing in talent development programs to ensure the workers are able to capture these advanced knowledge and skills to reconfigure and apply knowledge to ensure competitiveness and comparative advantage of the firms.

- Malaysia has increased the number of graduates in the S&T areas related to the electronics industry, and the graduates are good users of knowledge. However, there is a lack of creative talent that will lead to frontier technology development.
- The quantum of R&D spending and student enrolled into research program is significantly lower than pace-setter countries such as Germany, Taiwan, Korea and Japan.
- Furthermore, local talent prefers working in countries with more advanced electronic industry, where career prospects, remuneration and recognition are much better than that offered by the local industry.
- Industry-university partnership model is patchy and weak and this prevents both stakeholders from optimizing the resources they have and the potential for achieving a multiplier effect in terms of generating greater economies scale and scope in developing frontier innovation, processes, products and services. The weaknesses in the partnership model prevent firms, especially SMEs, from accessing the expertise and research facilities to improve their dynamic capabilities and translate these capabilities into new process improvements and product market development.
- There is low diffusion of ICTs among micro-SMEs; hence, many are not savvy in understanding market trends, information on competitors, resources and support provided by government.
- Local firms also do not have a strong market presence and client base compared to large MNCs, and hence are unable to get feedback for process improvement and new product development.
- Due to a lack of technical workers, talent, R&D capabilities, local firms are highly dependent on foreign firms for technology, especially the SMEs. This leads to a 'lock-in effect' for firms to focus only servicing their client and would be discouraged or not motivated to undertake R&D and innovation. Even highly innovative local firms are risk-averse in going the full mile of commercializing their IP. Many prefer 'cashing-out' their ideas, innovations and IPs to large and foreign firms.

7.4 Recommendations to Improve the Malaysian E&E (Components) Ecosystem

The E&E (components) industry has been the foundation for the Electronics and Electrical industry in Malaysia. It provides the support for Malaysia's transition from an agriculture based economy to an industrial powerhouse in the region. Intense competition from other regional economies will require the industry to enhance its knowledge content and move up the innovation value chain. To ensure a more knowledge intensive E&E (components) industry, a more holistic development of E&E (components) ecosystem is required over the next five years. Key recommendations to strengthen the electronics component ecosystem are discussed below.

Recommendation 7.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) within the E&E (components) Industry

Global E&E (components) industry are being shaped by a number of trends, which include the following:

- ❑ Innovations in semiconductors and the emergence of powerful chips that can be produced in a cost effective way and incorporated in all electrical and electronic devices;
- ❑ Internet of Things, semantics machine-to-machine communications that are transforming factories – emergence of smart devices, smart machines and smart factories; and,
- ❑ Emergence of Industry 4.0 and cyber-physical system, which requires next generation smart electronics components and devices that enables seamless connection, data on demand and foster sharing and collaboration.

Key polices and strategies to raise the competitiveness of the E&E (components) industry should take into account the local industry being at the forefront of developing next generation components for enabling cyber-physical systems that are critical for smart manufacturing technology, next generation robotics; and the convergence of virtual and physical systems.

Best Practice 7.1: Aligning German High-Technology Innovation Strategy to global trends.

Recommendation 7.2: Enhance the Knowledge Institutional System in E&E (components) Industry

- ❑ Enhance the Knowledge Institutional System of the E&E (components) Industry –the government is the orchestrator for supporting the development of the knowledge enablers such as developing a strong scientific and R&D base by providing funding for large research programs, infrastructure, industry-based CoEs, ensure appropriate talent development policies. The government also fosters strong partnership with industry associations in mapping direction of the industry and channelled resources and governance systems to ensure the industry continuously develop and are globally competitive.

Best Practice 7.2: German National Innovation Ecosystem

Recommendation 7.3: Develop the Knowledge Capital of the E&E (components) Industry

- ❑ Incorporate an Innovative Knowledge Approach within the E&E (components) Industry – a targeted approach in focusing R&D on key priority and strategic areas of development and put a systematic framework of engaging key external stakeholders (industry players) to foster the translation of research outcomes. This leads to new advanced technology, new applications, spawn new industries and services.

Best Practice 7.3: Fraunhofer Framework in enhance the impact and richness and impact of R&D in Germany.

Recommendation 7.4: Develop the Knowledge Competency of the E&E (components) Industry

- ❑ Develop the Knowledge Capital of the Electronics Components Industry – there is a strong emphasis on STEM and TEVT educational and training programs from certificate to post-doctoral training.

Best Practice 7.4: German Technical and Vocational Education

Recommendation 7.5: Facilitate Knowledge Learning & Transfer within the E&E (components) Industry

- ❑ Develop the Knowledge Competency for the E&E (components) Industry – clear mapping of the skill set needed at all levels of education – first skill level (primary education); second skill level (lower secondary education), third level (high school), fourth (training and certification – certificate course and specialized training), fifth level (higher qualifications – tertiary qualifications), sixth level (life-long learning). The core competencies cover planning, mounting, installing, inspecting designing, constructing, modifying, developing customized design, supervising teams, configuring, and testing. A clear path from training to provisional certification and obtaining higher education and research pathways are clearly articulated by skills development framework in most advanced countries.

Best Practice 7.5: The German Technical Education Skills Development Framework of "Berufskonzept' (Occupation) and 'Dualities' (industry-educational institution cooperative endeavour).

Recommendation 7.6: Incorporate an Innovative Knowledge Approach within the E&E (components) Industry

- ❑ Facilitate Knowledge Learning & Transfer within the E&E (components) Industry – a systematic framework in place for industry, especially SMEs, to gain access to leading-edge technology, expertise, R&D and innovations from universities, GRIs and Centres of Excellence.

Best Practice 7.6: The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) – nurturing and strengthening cooperative innovative endeavours in the E&E (components) industry

Recommendation 7.7: Strengthen the Knowledge Leverage within the E&E (components) Industry

- ❑ The Ecosystem has very Strong Knowledge Leverage within the E&E (components) Industry – the key institutions, such as Government and industry associations, provide various platforms, forums and 'One-Stop-Centre' for industry, researchers, universities and other stakeholders gain access to expert service, research facilities, training workshop, testing and other resources that will continuously build knowledge and become a knowledge hub for the industry.

Best Practice 7.7: The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) – important knowledge resource for all stakeholders in the E&E (components) industry.

7.5 Conclusion

In this chapter, the state of development of the knowledge ecosystem for the Malaysian E&E (components) industry were examined carefully using the proposed knowledge ecosystem model. The chapter identifies key strengths and gaps in the knowledge ecosystem for of the Malaysian E&E (components); and policies and strategies to strengthen the enablers of the ecosystem were discussed in this chapter. The analysis shows that for the Malaysian E&E (components) industry to move up the knowledge and innovation value chain, the quantum and quality of R&D and talent needs to be intensified. Further, refinement in the organizational set-up of the R&D management systems by incorporating Industry4.0 Philosophy and Fraunhofer approach will go a long way in raising the dynamic capabilities, knowledge content and competitiveness of the local E&E (Components) industry.

Appendix for Chapter 7

Case-Study 7.1: The E&E (Components) Industry in Germany

The German electronics industry is one of the most globally competitive industries, contributing EUR 178.5 billion to the economy in 2015[18]. The industry is highly innovative, spending close to EUR15 billion in R&D activities through various research institutes and centres of excellence in Germany and across the globe. The industry is also supported by a strong technically competent workforce. To enhance its global market reach and richness, a number of strategies were pursued by the German electronics industry and they are outlined below.

Best Practice 7.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) within the E&E (Components) Industry

The industry has benefitted from the new High-Tech Strategy and Innovation, which focused on six areas: digital economy and society; sustainable economy and energy; innovative workplace; health living; intelligence mobility; and civil security. The focused areas incorporate the following technology that have significant spill-over impact on the E&E (Components) industry: Industry 4.0; Smart Services (internet bases services); Smart data; Digital Networking; Cloud Computing Digital education platforms and Cloud Computing. These new technology ecosystems have enhanced interaction between the physical and virtual environment, leading to new smart manufacturing and production systems. The new cyber-physical systems are transforming value production value chains and business models. The German government, in partnership with industry, trade associations, universities and research institutes, works to ensure that the cyber-physical systems underpin the strategic plan of the E&E (components) industry.

[18]Source: Consulate General of India in Frankfurt (2016).

Best Practice 7.2: Enhance the Knowledge Institutional System of the E&E (Components) Industry

The E&E Components industry is a major beneficiary of the systematic and coordinated national innovation system that is present in Germany. Though the planning is centrally coordinated through the central government and Lander (Federal States), resources are channelled through several institutes and associations to plan and implement the strategies and programs that enable firms and institutions in the industry to make important scientific discoveries, improve production processes and enhance new product development. Among the key institutes that are important driver of innovations in the E&E (components) industry include the following:

- The Science Council – coordinate and provide advice on development of institution of higher learning, science and research. It also evaluates and accredits research institutions, ensuring that research quality and standards contribute to the strategic priority areas of the country and enhance the national innovation system;
- The German Research Foundation – provide financial support for research that is aligned to national priority areas in all fields.
- The Herman von Helmholtz Association of Research Centres – research centres that focus efforts in biomedicine, science and technology.
- The Max Planck Society for the Advancement of Science – an independent and not-for-profit research organisation with over 80 research institutes research in a wide range of multidisciplinary research in the natural science, life sciences and humanities areas.

- The Fraunhofer Society/Institutes – undertake applied R&D activities that are strategic to the development of the nation and global community through a strong multi-stakeholder partnership model between universities, research institutes, government, industry and the community.

- The Leibniz Science Association - the institutes of this association not only undertake research, but are also an important resource centre for all stakeholders in the industry. It provides advice on technology/knowledge transfer, testing facilities, expertise and other research support services.

- The Centre for Advanced European Studies and Research (CAESAR) Foundation – undertakes basic and applied research in nanotechnology, biotechnology and neuroscience. The foundation also undertakes translational research linking basic scientific discoveries to innovations that are important for industry.

Best Practice 7.3: Incorporate an Innovative Knowledge Approach within the E&E (Components) Industry

The industry incorporates the Fraunhofer-Gesellschaft approach for ensuring that basic research is complemented with a strong applied and translational research that have knock-on effect beyond the E&E (components) industry, but also on other complementing industries and ultimately benefitting the customers and the broader economy. Staff in Fraunhofer-Gesellschaft provide a holistic talent development, which enable a person to take up employment in an institute, universities, industry or society. Internship with Fraunhofer Institutes open up excellent job opportunities for students in major leading industries.

[19]Source: Consulate General of India in Frankfurt (2016).

[20]Source: Consulate General of India in Frankfurt (2016).

Best Practice 7.4: Develop the Knowledge Capital of the E&E (Components) Industry

The E&E (components) industry has one of the highest knowledge capital in the world through its strong and active technical workforce of 849,000 in Germany and another 677,000 across the globe[19]. To keep pace with technological development, Germany has invested significantly in nurturing research talent through its various research institutes. There are also more than 79,000 R&D workers in the industry that provide solutions for all other German industries[20].

Best Practice 7.5: Develop the Knowledge Competency of the E&E (Components) Industry

The knowledge competency of the German E&E (Components) industry has been undergoing rapid changes due to various scientific and technological developments, especially with the converging technology platforms. To ensure the industry is keeping pace with global developments, the German government has established a competence matrix for the electronics and electrical engineering sector. The competence matrix, clearly maps 8 group competencies, covering from planning, mounting and installing E&E systems to designing and developing systems. For more information, refer to: Becker (2009) and Human Capacity Development (HCD) for Vocational Education and Training (2011).

Best Practice 7.6: Facilitate Knowledge Learning and Transfer within the E&E (Components) Industry

The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) is undertaking research in high frequency for communication technology and other innovative semiconductor technology, electronic and optoelectronic devices that wide applications.

- The institute works closely with major industry players such as Bosh, OSRAM, Infineon and major research universities.

- The institute enables students and staff from universities to exchange knowledge with leading researchers from the institute and other industry leaders – provide an excellent networking opportunities for all stakeholders in the ecosystem.

For more information on the Fraunhofer IAF, please visit: https://www.iaf.fraunhofer.de/en/institute.html

Best Practice 7.7: Strengthen the Knowledge Leverage within the Dairy Industry

The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) also provides a wide range of services for the key players in the electronics, optoelectronics and sensing. These include the following resources: access the lab and testing facilities; expertise; access to new technology and innovations; training and consulting services; workshops and trainings.

For more information on the Fraunhofer IAF, please visit: https://www.iaf.fraunhofer.de/en/institute.html

References

1. Becker, M. (2009), Competence matrix for the sector electronics/electrical engineering, Human Capacity Development (HCD) for Vocational Education and Training, Mannheim, Germany.

2. Collaborative Research in Engineering Science and Technology (CREST). (2015). About CREST. Retrieved from http://crest.my/v2/about-page/

3 Consulate General of India (2016), Electronic Components Industry in Germany: A Market Study, http://indiainbusiness.nic.in/newdesign/upload/electronic-components-industry-in-germany.pdf.

4. Federal Ministry of Education and Research – Germany (2014), The new High-Tech Strategy Innovation for Germany, FMER, Germany. https://www.bmbf.de/pub/HTS_Broschuere_eng.pdf

Human Capacity Development (HCD) for Vocational Education and Training (2011), Structures and functions of Competence-based Education and Training (CBET): A Comparative Perspective.

CHAPTER 8

KNOWLEDGE CONTENT OF THE MALAYSIAN ELECTRICAL & ELECTRONIC (FINAL PRODUCTS) ECOSYSTEM

CHAPTER 8
Knowledge Content of the Malaysian Electrical & Electronic (Final Products) Ecosystem

8.0 Introduction

In this chapter, the knowledge ecosystem of the Malaysian E&E (final products) industry is examined. The industry is a major contributor to wealth Malaysia's wealth and primarily consists of consumer and industrial electronics and electrical subsector. The consumer electronics mainly consists of the manufacturing of LED television, receivers, audio visual products, electronic games consoles and digital cameras. Industrial electronics consists primarily of the manufacturing of ICT equipment (computers, computer peripherals, telecommunication products) and office equipment's. Electrical products mainly consist of lighting, solar related equipment and household appliances (air-conditioners, refrigerators, washing machines and vacuum cleaners). The local industry is dominated by major players from Japan and Korea, who have played a key role in the rapid growth of the industry.

This industry has experienced intense competition from two different fronts. First, increasing demand for new generation smart electrical products that have incorporated cyber-physical systems, rendering many traditional E&E (final products) out of date. Convergence in technology platforms are prioritising unification of devices (consumer do not need to purchase multiple devices for different functions and activities). Consolidation of devices will lower demand for stand-alone E&E (final products).

Second, increasing competition from regional players who are in a better position than local firms to pursue economies of scale and scope. Many of the foreign firms from China, Germany, Korea, US and Japan, have access to some of the best technology and have larger labour pools to drive cost down. These firms also have invested substantial resources into creating new designs and models of E&E products at a much faster pace. Local firms that are dependent on foreign technology, tend to be at the lower end of the value chain than their counterparts from China, Germany, Korea, US and Japan. To raise the competitiveness of local E&E (final products) industry, the key enablers of the knowledge ecosystem should be strengthened so that the industry is able to raise its absorptive, adaptive and innovative capabilities.

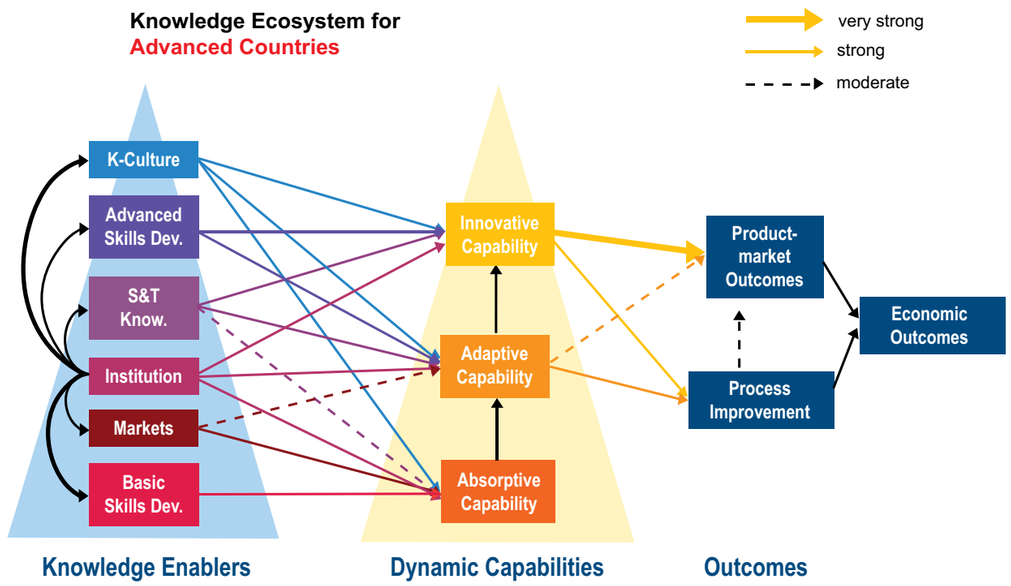
In this chapter, we examine the knowledge ecosystems of the E&E (final products) industry using the MYKE-III knowledge ecosystem model for a sample of 242 firms operating in Malaysia. From the sample, 96 are large firms, 146 are micro-SMEs, 120 local and 122 foreign firms. The E&E (final products) industry consists of the following sub-industries: computers and peripheral equipment; communication equipment; consumer electronics; measuring, testing, navigating and control equipment; watches and clocks; irradiation, electro medical and electrotherapeutic equipment; optical instruments and photographic equipment; electric lighting equipment; domestic appliances; and electrical equipment.

The chapter is organized as follows: In Section 8.1, a description of a knowledge ecosystem of the E&E (final products) industry in an advanced country is provided. In Section 8.2, we provide a description of the knowledge ecosystem for the Malaysian E&E (final products. In Section 8.3, the essay discusses the key strengths and gaps in the Malaysian E&E (final products) ecosystem. In Section 8.4, key recommendations to improve the knowledge ecosystem of the Malaysian E&E (components) industry are provided before concluding in Section 8.5.

8.1 Knowledge Ecosystem for the E&E (Final Products) Industry in an Advanced Country

The knowledge ecosystem for the E&E (final products) is captured in Figure 8.1. It is clear that the knowledge enablers for this industry in advanced countries are very strong and can support the development of the three dynamic capability components. The strength in the dynamic capability components enable the industry generate process improvement and product market development, contributing to the economic wealth of the countries.

Figure 8.1: Complex Relationships in the E&E (Final Products) in an Advanced Country



In many of these advanced countries the development of the knowledge ecosystem is attributed to the following initiatives undertaken to raise the knowledge content and competitiveness of the industry:

- *Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the E&E (final products) industry* – recent innovations in ICT and the convergence of technological platforms (cyber-physical systems) has led to emergence of next generation smart appliances and equipment. The demand for the E&E (final products) are on an exponential trajectory and are slowly displacing traditional and 'stand-alone' devices. Countries that are at the forefront of developing these new generation E&E (final products) are also changing the development and delivery of products and services. Innovations in this space are also leading the emergence of more collaborative networks, business and economic models. *Best Practice 7.1: Aligning German High-Technology Innovation Strategy to global trends.*

- *Enhance the Knowledge Institutional System of the E&E (final products) Industry* – in most advanced countries, government agencies play an orchestrating role in ensuring that key resources are channelled to the industry to strengthen the knowledge enablers and directly influence the dynamic capabilities. Various institutes, academies, trade associations and government agencies were established to spearhead the development of the industry. They work closely to plan, implement and monitor progress of the strategic master plans with the primary objective of the industry being at the fore-front of the technology and innovation development. A robust governance framework is in place in most of the advanced countries to ensure continuous development are aligned to priorities. *Best Practice 7.2: German National Innovation Ecosystem.*

- *Incorporate an Innovative Knowledge Approach within the E&E (final products) Industry* – increasingly in many of the developed and developing countries, there is greater recognition in the role of basic R&D in STEM related areas and the importance of translating these research outcomes to the benefits of the industry. One of the knowledge approaches that has gained popularity is the Fraunhofer Framework, which endeavours to establish strong partnership between academic, research institutes and industry to increase translational research that benefit the industry and the community. The approach not only increases rapid innovation for the benefit to industry and community, it also leads to positive spill-over benefits for educational institutions and industry. *Best Practice 7.3: Fraunhofer Institute in Germany*.

- *Develop the Knowledge Capital of the E&E (final products) Industry* – in many of the pace-setter countries, there is a strong emphasis in STEM education at all levels and this is complemented by a sound TEVT educational and training ecosystem that support non-academic inclined students to develop a career path in E&E (final products) industry. The education and training programs include multidisciplinary knowledge that enable students and workers to work across multiple industries and designing new tools and products to enhance process improvement and new product market development. There is also a strong collaborative environment among leading centres of excellence across the globe to share best practices and foster technology/knowledge transfer. *Best Practice 7.4 (German Technical and Vocational Education).*

- Develop the Knowledge Competency for the E&E (final products) Industry – in most of the pace-setter countries, there is clear mapping of the skill set needed to meet the manpower and talent needs of the industry. The national qualification agency works very closely with educational institutions and training providers to ensure the skill set are continuously upgraded to keep pace with the changes taking place in the industry. The core competencies are assessed from the primary until tertiary education, including technical and vocational training. The core competencies of the industry cover a wide range of from planning, mounting, installing, inspecting designing, constructing, modifying, developing customized design, supervising teams, configuring, and testing. Furthermore, all these countries have a clear pathway to transition a student/worker from provisional certification to higher diploma and possibly to tertiary qualifications. *Best Practices: refer to the Best Practice 7.5: The German Technical Education Skills Development Framework of "Berufskonzept' (Occupation) and 'Dualities' (industry-educational institution cooperative endeavour).*

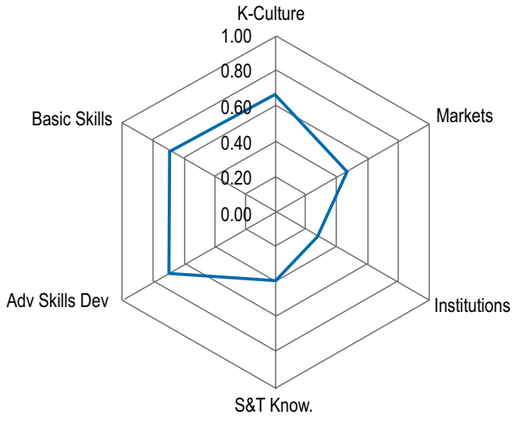
- *Facilitate Knowledge Learning & Transfer within the E&E (final products)* – most of the countries have an effective mechanism to foster strong industry-university-government research institute collaboration, especially in key research priority areas. *Best Practice 7.6: The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) – nurturing and strengthening cooperative innovative endeavours in the E&E (components) industry.*

- T*he Ecosystem has very Strong Knowledge Leverage within the E&E (components) Industry* – pace-setter countries have a number of institutions, the universities and CoEs that are important resource centres ('One-Stop-Centre') for industry, researchers and other stakeholders in the industry. The facilities provide a wide range of services, which include contract research, access to research facilities and expertise, training workshop, testing and other business development resources. *Best Practice 7.7: The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) – important knowledge resource for all stakeholders in the E&E (components) industry.*

8.2 Knowledge Ecosystem of the Malaysian E&E (Final Product) Industry

Figure 8.2 shows the state of development of the knowledge enablers for the E&E (final product) industry. Three of the knowledge enablers (institutions, S&T knowledge and market intelligence) are performing below optimal level (below 0.5); while three of the enablers (basic skills, advanced skills and k-culture) are performing at the moderate level, between 0.5 and 0.8.

Figure 8.2: Knowledge Enablers for the E&E (Final Product) Industry

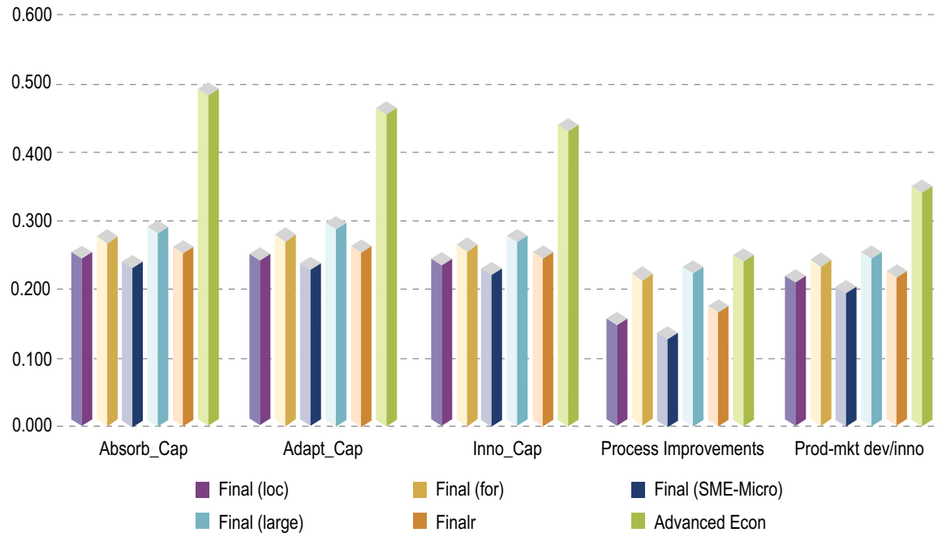


Note: If 0 ≤ x < 0.5, the enablers are weak; if 0.5 ≤ x < 0.8, the enablers are moderately developed; and if 0.8≤ x ≤ 1, the enablers are highly developed.

The dynamic capability components, process improvement and product development for the Malaysian E&E (final product) industry are shown in Figure 8.3. The dynamic capability, process improvement and product development for advanced countries were found to be significantly higher than that of the Malaysian E&E (final product) industry. The study also found that foreign firms has significantly higher absorptive, adaptive and innovative capabilities than local firms. Similarly, larger firms were found to have higher absorptive, adaptive and innovative capabilities than micro-SMEs. The empirical analysis also shows that process improvement and product development for foreign and large firms are higher than that of local and micro-SMEs.

Strategic postures of firms in the Malaysian E&E (final product) industry are given in Figure 8.4. The figure shows that percentage of firms based on the strategic posture are as follows: Analyser firms is 31%; Prospector firms, 14%; Defender firms, 12%; Reactor firms, 10%; Defender-Analyser at11%, Analyser-Prospector, 5% and Defender-Prospector, 2%. A significant percentage of the firms adopt a mixed strategic posture, 15%. The analysis show that the percentage of innovators (Prospector Firms) are relatively higher than other industries. This suggests that the local industry has a few highly innovative firms in the local industry.

Figure 8.3: State of the Dynamic Capabilities of the E&E (Final Product) Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

Figure 8.4: Strategic Posture of Firms in the Malaysian E&E (Final Product) Industry

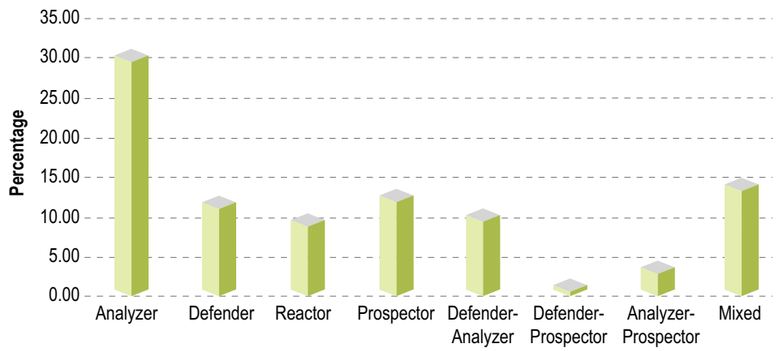
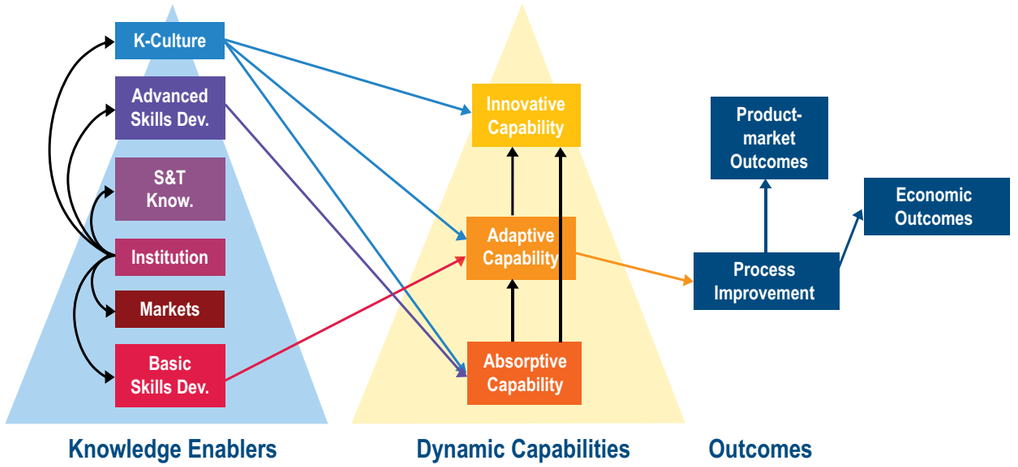


Figure 8.5: Knowledge Ecosystem of the E&E (Final Product) Industry



The E&E (final product) knowledge ecosystem is shown in Figure 8.5; which shows that institutions have a significant impact on all the enablers. Basic skill development was found to have a positive impact on adaptive capability. Advanced skills have a significant impact on absorptive capability. Knowledge culture was found to have significant impact on all three dynamic capabilities. The ecosystem also shows that firms are able to transition from absorptive capability to adaptive capability; and finally transition from adaptive capability to innovative capability. Similar to the E&E (Component), some firms try to 'leap-frog' from absorptive to innovative capability. Only adaptive capability was found to contribute to process improvement and economic outcome. Though process improvement led to product market outcomes; it did not contribute to economic outcomes.

Figure 8.6 shows that impact of institutions on S&T knowledge on adaptive capability was found to be higher for micro-SMEs than for larger firms. Figure 8.7 shows that S&T knowledge on adaptive capability is higher for micro-SMEs than larger firms. However,

Figure 8.6: Knowledge Ecosystem for E&E (Final Product) Industry (Multi-Group-Analysis: Large versus Micro-SME firms)

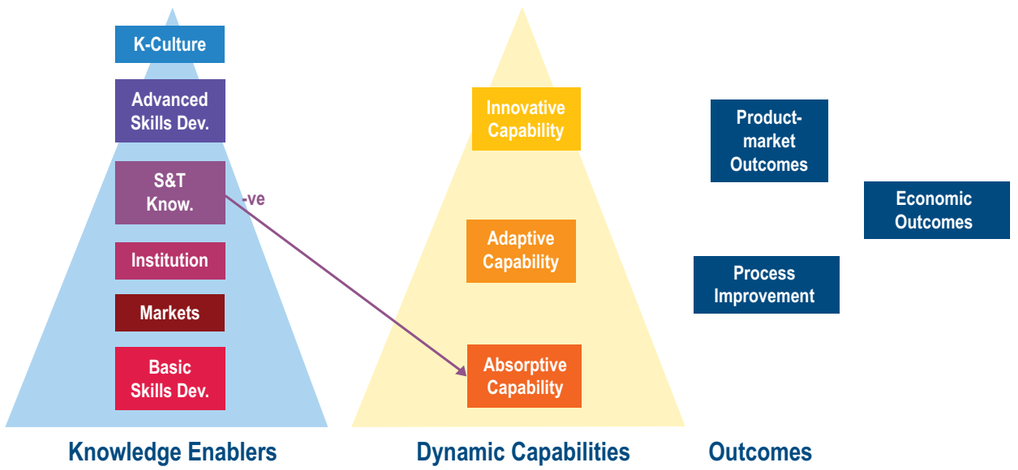
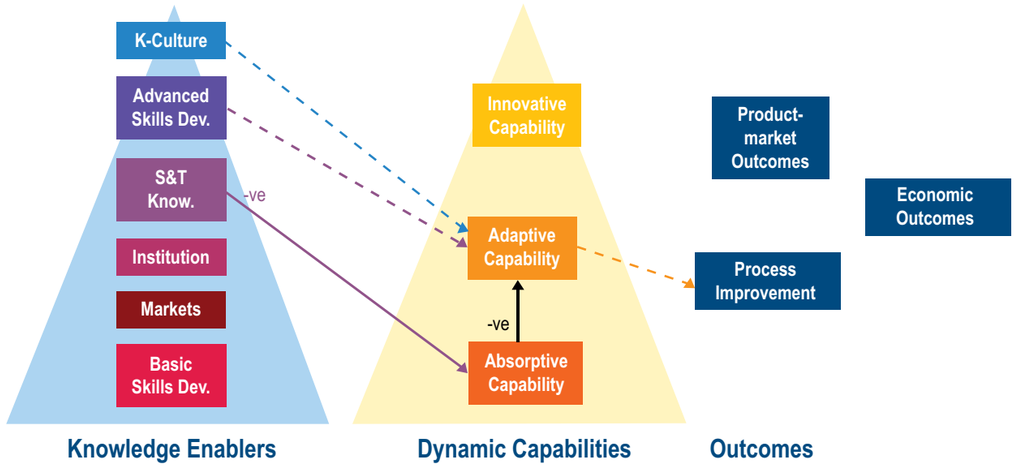


Figure 8.7: Knowledge Ecosystem for E&E (Final Product)
(Multi-Group-Analysis: Foreign versus Component Local)



advanced skills and k-culture on adaptive capability is higher for larger firms than micro-SMEs. The transition from absorptive to adaptive capability was found to be higher for micro-SMEs than larger firms. The larger firms were found to translate the adaptive capability to process improvement more effectively than micro-SMEs.

The impact of knowledge enablers on dynamic capability components, process improvement, product market development and economic outcomes for local and foreign firms are shown in Figure 8.7. The figure shows that the impact of S&T knowledge on innovative capability is higher for local firms than foreign firms. Local firms are also able to translate process improvement into product market development more efficiently than foreign firms. On the other hand, foreign firms are in a better position to translate adaptive capability into innovative capability.

In summary, micro-SMEs tend to be able to generate greater absorptive capability than larger firms. On the other hand, larger firms tend to be in a better position to nurture adaptive capability than micro-SMEs. Further, larger firms have a more significant impact on process improvement than micro-SMEs.

8.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian E&E (Final Products) Industry

Based on the analysis of the knowledge ecosystem of the E&E (final products) industry, the key strengths and gaps of the ecosystem are provided below.

Key Strengths of the E&E (Final Products) Ecosystem:

- Similar to the E&E (components) industry, this industry has received strong support for the Malaysian government to become knowledge intensive. This is in the form of various fiscal (tax deductions and grants) and non-fiscal (access to good infrastructure and talented labour pool) incentives.

- The industry also benefited in the form of technology/knowledge transfer with the entry of leading players from Japan, Korea and US into the domestic market.

- Various research institutes were established to spearhead R&D and innovations among local firms. Among the key initiatives includes the establishment of CREST, MIMOS, SIRIM, Multimedia University and various research centres in both public and private universities.

Key Gaps E&E (Final Product) Ecosystem:

- As in the E&E (Final Product) industry, the development of this industry was rather ad hoc, driven primarily by foreign firms.

- Lack of technical staff and TEVT education ecosystems causes Malaysia to lag behind other pace-setter countries.

- A majority of local graduates in the STEM related areas are users of the technology and not creators of new designs and applications (lack of creative talent in the industry. The best talent is poached by foreign MNCs and seek employment in foreign countries.

- The quantum of R&D spending is relatively low compared to most of the OECD countries in this space.

- Industry-university partnership is relatively weak, hence both institutions are unable to derive the positive spill-over impact.

- Local firms also do not have access to a wider global market supply chain compared to their counterparts from Japan, Korea and the USA.

- Lack of talent and under-investment in technological infrastructure, which means the industry is unable to leap-frog to building innovative capacity that will lead to stronger product market development.

8.4 Recommendations to Improve the Malaysian E&E (Final Products) Ecosystem

Key recommendations to strengthen the E&E (final product) ecosystem are outlined below.

Recommendation 8.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) within the E&E (final product) Industry

The industry is undergoing major transformation due to the Industry 4.0 revolution. Hence, policies and strategies to raise the knowledge content, innovative capability and competitiveness should be aligned to building up the knowledge enablers that will lead the integration of Industry4.0 as core the strategic global positioning of the industry.

Best Practice 7.1: Aligning German High-Technology Innovation Strategy to global trends.

Recommendation 8.2: Enhance the Knowledge Institutional System in E&E (final product) Industry

- *Enhance the Knowledge Institutional System of the E&E (final product) Industry* –government has to play a key role in creating appropriate institutional framework and governance systems that will provide the necessary resources and support system to create a forward look and business friendly environment for transforming Malaysia as a hub for testing and developing new products and service. This will require strong institutions that undertake scientific research, funding agencies, match-making institutions, CoEs and education and training institutes that will work close with industry and industry associations to continuously improve and enhance the industry's market reach for resources, networks and markets.

Best Practice 7.2: German National Innovation Ecosystem

Recommendation 8.3: Incorporate an Innovative Knowledge Approach within the E&E (final product) Industry

- *Facilitate Knowledge Learning & Transfer within the E&E (final product) Industry* – similar to the E&E (components) industry, there should be a framework for firms to gain access to expertise, research facilities and IP/patents from universities and GRIs to develop cutting-edge technology and discoveries that will enhance their competitiveness. The Fraunhofer Institute provide excellent model for strengthening the "triple-helix" to generate greater multiplier effect from the R&D and innovation undertaken by all parties.

Best Practice 7.3: Fraunhofer Institute in Germany

Recommendation 8.4: Develop the Knowledge Capital of the E&E (final product) Industry

- *Incorporate an Innovative Knowledge Approach within the E&E (final product) Industry* – strong focus in STEM related education and research programs. This includes good support for sound basic research and incentives to intensify applied and translational research. A key framework that is widely used in many countries is the Fraunhofer framework that builds strong university-industry partnership model.

Best Practice 7.4 (German Technical and Vocational Education).

Recommendation 8.5: Develop the Knowledge Competency of the E&E (final product) Industry

- *Develop the Knowledge Capital of the E&E (final product) Industry* – there is a strong emphasis on STEM and TEVT educational and training programs from certificate to post-doctoral training.

Best Practice 7.5: The German Technical Education Skills Development Framework of "Berufskonzept' (Occupation) and 'Dualities' (industry-educational institution cooperative endeavour).

Recommendation 8.6: Facilitate Knowledge Learning & Transfer within the E&E (final product) Industry

- In most of the leading countries, the CoE and GRIs are key institutions that enable technology/ knowledge transfer between researcher and industry. Federal funding should be channelled to local universities and GRIs to provide industry access to expertise, research facilities and other resources that will enable them to build their knowledge content and competitiveness.

Best Practice 7.6: The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) – nurturing and strengthening cooperative innovative endeavours in the E&E (final product).

Recommendation 8.7: Strengthen the Knowledge Leverage within the E&E (final product) Industry

- *The Ecosystem has very Strong Knowledge Leverage within the E&E (final product) Industry* – the GRIs and CoEs in the public and private universities can play a key role in the ecosystem to be resource centres for the research community, industry and policy-makers across the nation.

Best Practice 7.7: The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) – important knowledge resource for all stakeholders in the E&E (components) industry.

8.5 Conclusion

The state of the knowledge ecosystem for the Malaysian E&E (final product) industry was presented in this chapter. One of the key features of the ecosystem is that most firms are only generating process improvement; however, very few are able to translate innovative capability into product market development. In this chapter, we identify key strengths and gaps in the knowledge ecosystem for the Malaysian E&E (final product). Based on the gaps in the ecosystem, several policies and strategies to strengthen the enablers of the ecosystem were discussed in this chapter.

CHAPTER 8

KNOWLEDGE CONTENT OF THE MALAYSIAN ELECTRICAL & ELECTRONIC (FINAL PRODUCTS) ECOSYSTEM

CHAPTER 8
Knowledge Content of the Malaysian Electrical & Electronic (Final Products) Ecosystem

8.0 Introduction

In this chapter, the knowledge ecosystem of the Malaysian E&E (final products) industry is examined. The industry is a major contributor to wealth Malaysia's wealth and primarily consists of consumer and industrial electronics and electrical subsector. The consumer electronics mainly consists of the manufacturing of LED television, receivers, audio visual products, electronic games consoles and digital cameras. Industrial electronics consists primarily of the manufacturing of ICT equipment (computers, computer peripherals, telecommunication products) and office equipment's. Electrical products mainly consist of lighting, solar related equipment and household appliances (air-conditioners, refrigerators, washing machines and vacuum cleaners). The local industry is dominated by major players from Japan and Korea, who have played a key role in the rapid growth of the industry.

This industry has experienced intense competition from two different fronts. First, increasing demand for new generation smart electrical products that have incorporated cyber-physical systems, rendering many traditional E&E (final products) out of date. Convergence in technology platforms are prioritising unification of devices (consumer do not need to purchase multiple devices for different functions and activities). Consolidation of devices will lower demand for stand-alone E&E (final products).

Second, increasing competition from regional players who are in a better position than local firms to pursue economies of scale and scope. Many of the foreign firms from China, Germany, Korea, US and Japan, have access to some of the best technology and have larger labour pools to drive cost down. These firms also have invested substantial resources into creating new designs and models of E&E products at a much faster pace. Local firms that are dependent on foreign technology, tend to be at the lower end of the value chain than their counterparts from China, Germany, Korea, US and Japan. To raise the competitiveness of local E&E (final products) industry, the key enablers of the knowledge ecosystem should be strengthened so that the industry is able to raise its absorptive, adaptive and innovative capabilities.

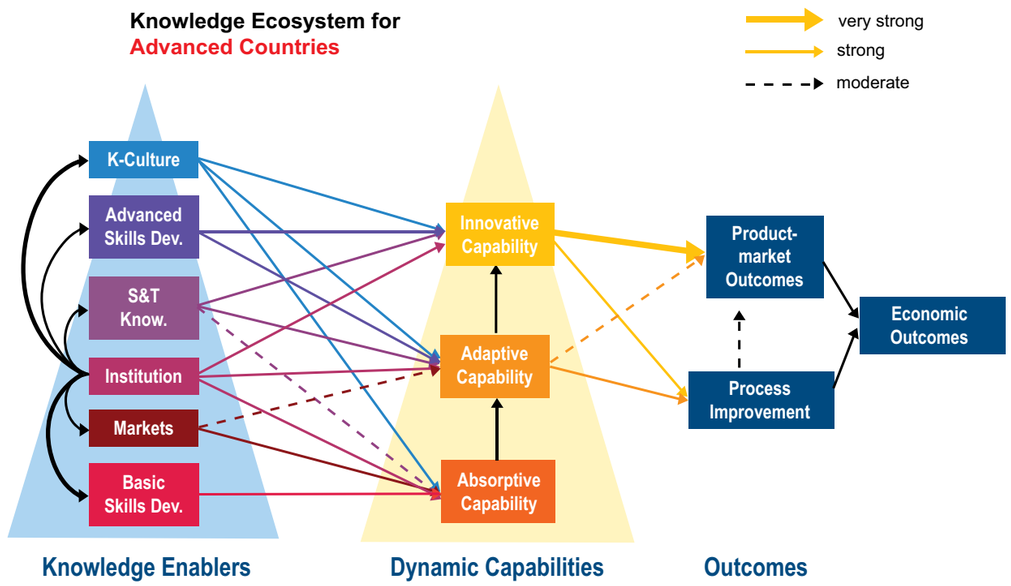
In this chapter, we examine the knowledge ecosystems of the E&E (final products) industry using the MYKE-III knowledge ecosystem model for a sample of 242 firms operating in Malaysia. From the sample, 96 are large firms, 146 are micro-SMEs, 120 local and 122 foreign firms. The E&E (final products) industry consists of the following sub-industries: computers and peripheral equipment; communication equipment; consumer electronics; measuring, testing, navigating and control equipment; watches and clocks; irradiation, electro medical and electrotherapeutic equipment; optical instruments and photographic equipment; electric lighting equipment; domestic appliances; and electrical equipment.

The chapter is organized as follows: In Section 8.1, a description of a knowledge ecosystem of the E&E (final products) industry in an advanced country is provided. In Section 8.2, we provide a description of the knowledge ecosystem for the Malaysian E&E (final products. In Section 8.3, the essay discusses the key strengths and gaps in the Malaysian E&E (final products) ecosystem. In Section 8.4, key recommendations to improve the knowledge ecosystem of the Malaysian E&E (components) industry are provided before concluding in Section 8.5.

8.1 Knowledge Ecosystem for the E&E (Final Products) Industry in an Advanced Country

The knowledge ecosystem for the E&E (final products) is captured in Figure 8.1. It is clear that the knowledge enablers for this industry in advanced countries are very strong and can support the development of the three dynamic capability components. The strength in the dynamic capability components enable the industry generate process improvement and product market development, contributing to the economic wealth of the countries.

Figure 8.1: Complex Relationships in the E&E (Final Products) in an Advanced Country



In many of these advanced countries the development of the knowledge ecosystem is attributed to the following initiatives undertaken to raise the knowledge content and competitiveness of the industry:

- *Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the E&E (final products) industry* – recent innovations in ICT and the convergence of technological platforms (cyber-physical systems) has led to emergence of next generation smart appliances and equipment. The demand for the E&E (final products) are on an exponential trajectory and are slowly displacing traditional and 'stand-alone' devices. Countries that are at the forefront of developing these new generation E&E (final products) are also changing the development and delivery of products and services. Innovations in this space are also leading the emergence of more collaborative networks, business and economic models. *Best Practice 7.1: Aligning German High-Technology Innovation Strategy to global trends.*

- *Enhance the Knowledge Institutional System of the E&E (final products) Industry* – in most advanced countries, government agencies play an orchestrating role in ensuring that key resources are channelled to the industry to strengthen the knowledge enablers and directly influence the dynamic capabilities. Various institutes, academies, trade associations and government agencies were established to spearhead the development of the industry. They work closely to plan, implement and monitor progress of the strategic master plans with the primary objective of the industry being at the fore-front of the technology and innovation development. A robust governance framework is in place in most of the advanced countries to ensure continuous development are aligned to priorities. *Best Practice 7.2: German National Innovation Ecosystem.*

- *Incorporate an Innovative Knowledge Approach within the E&E (final products) Industry* – increasingly in many of the developed and developing countries, there is greater recognition in the role of basic R&D in STEM related areas and the importance of translating these research outcomes to the benefits of the industry. One of the knowledge approaches that has gained popularity is the Fraunhofer Framework, which endeavours to establish strong partnership between academic, research institutes and industry to increase translational research that benefit the industry and the community. The approach not only increases rapid innovation for the benefit to industry and community, it also leads to positive spill-over benefits for educational institutions and industry. *Best Practice 7.3: Fraunhofer Institute in Germany*.

- *Develop the Knowledge Capital of the E&E (final products) Industry* – in many of the pace-setter countries, there is a strong emphasis in STEM education at all levels and this is complemented by a sound TEVT educational and training ecosystem that support non-academic inclined students to develop a career path in E&E (final products) industry. The education and training programs include multidisciplinary knowledge that enable students and workers to work across multiple industries and designing new tools and products to enhance process improvement and new product market development. There is also a strong collaborative environment among leading centres of excellence across the globe to share best practices and foster technology/knowledge transfer. *Best Practice 7.4 (German Technical and Vocational Education).*

- Develop the Knowledge Competency for the E&E (final products) Industry – in most of the pace-setter countries, there is clear mapping of the skill set needed to meet the manpower and talent needs of the industry. The national qualification agency works very closely with educational institutions and training providers to ensure the skill set are continuously upgraded to keep pace with the changes taking place in the industry. The core competencies are assessed from the primary until tertiary education, including technical and vocational training. The core competencies of the industry cover a wide range of from planning, mounting, installing, inspecting designing, constructing, modifying, developing customized design, supervising teams, configuring, and testing. Furthermore, all these countries have a clear pathway to transition a student/worker from provisional certification to higher diploma and possibly to tertiary qualifications. *Best Practices: refer to the Best Practice 7.5: The German Technical Education Skills Development Framework of "Berufskonzept' (Occupation) and 'Dualities' (industry-educational institution cooperative endeavour).*

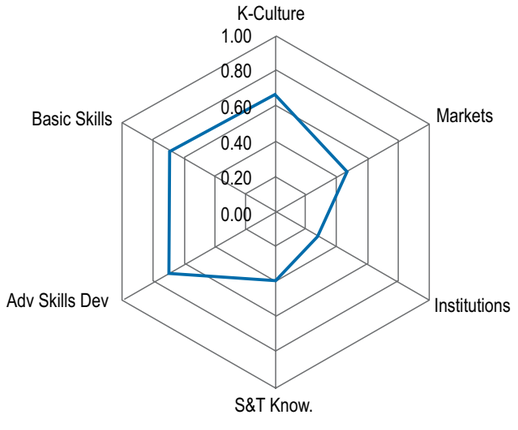
- *Facilitate Knowledge Learning & Transfer within the E&E (final products)* – most of the countries have an effective mechanism to foster strong industry-university-government research institute collaboration, especially in key research priority areas. *Best Practice 7.6: The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) – nurturing and strengthening cooperative innovative endeavours in the E&E (components) industry.*

- T*he Ecosystem has very Strong Knowledge Leverage within the E&E (components) Industry* – pace-setter countries have a number of institutions, the universities and CoEs that are important resource centres ('One-Stop-Centre') for industry, researchers and other stakeholders in the industry. The facilities provide a wide range of services, which include contract research, access to research facilities and expertise, training workshop, testing and other business development resources. *Best Practice 7.7: The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) – important knowledge resource for all stakeholders in the E&E (components) industry.*

8.2 Knowledge Ecosystem of the Malaysian E&E (Final Product) Industry

Figure 8.2 shows the state of development of the knowledge enablers for the E&E (final product) industry. Three of the knowledge enablers (institutions, S&T knowledge and market intelligence) are performing below optimal level (below 0.5); while three of the enablers (basic skills, advanced skills and k-culture) are performing at the moderate level, between 0.5 and 0.8.

Figure 8.2: Knowledge Enablers for the E&E (Final Product) Industry

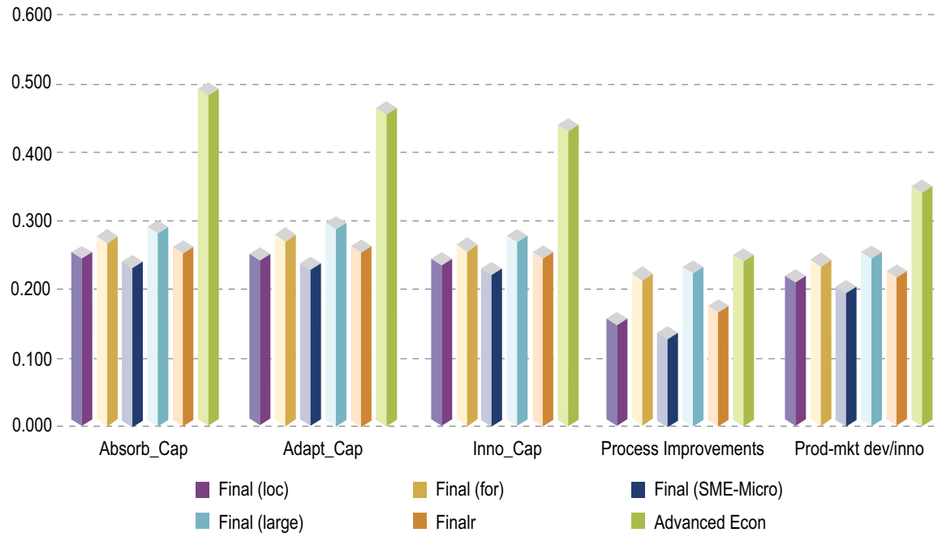


Note: If 0 ≤ x < 0.5, the enablers are weak; if 0.5 ≤ x < 0.8, the enablers are moderately developed; and if 0.8≤ x ≤ 1, the enablers are highly developed.

The dynamic capability components, process improvement and product development for the Malaysian E&E (final product) industry are shown in Figure 8.3. The dynamic capability, process improvement and product development for advanced countries were found to be significantly higher than that of the Malaysian E&E (final product) industry. The study also found that foreign firms has significantly higher absorptive, adaptive and innovative capabilities than local firms. Similarly, larger firms were found to have higher absorptive, adaptive and innovative capabilities than micro-SMEs. The empirical analysis also shows that process improvement and product development for foreign and large firms are higher than that of local and micro-SMEs.

Strategic postures of firms in the Malaysian E&E (final product) industry are given in Figure 8.4. The figure shows that percentage of firms based on the strategic posture are as follows: Analyser firms is 31%; Prospector firms, 14%; Defender firms, 12%; Reactor firms, 10%; Defender-Analyser at11%, Analyser-Prospector, 5% and Defender-Prospector, 2%. A significant percentage of the firms adopt a mixed strategic posture, 15%. The analysis show that the percentage of innovators (Prospector Firms) are relatively higher than other industries. This suggests that the local industry has a few highly innovative firms in the local industry.

Figure 8.3: State of the Dynamic Capabilities of the E&E (Final Product) Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

Figure 8.4: Strategic Posture of Firms in the Malaysian E&E (Final Product) Industry

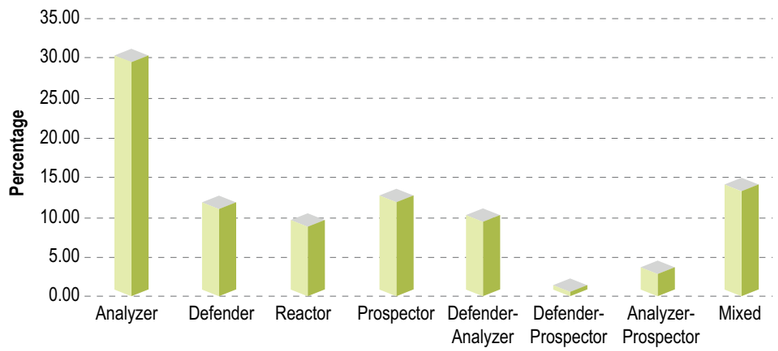
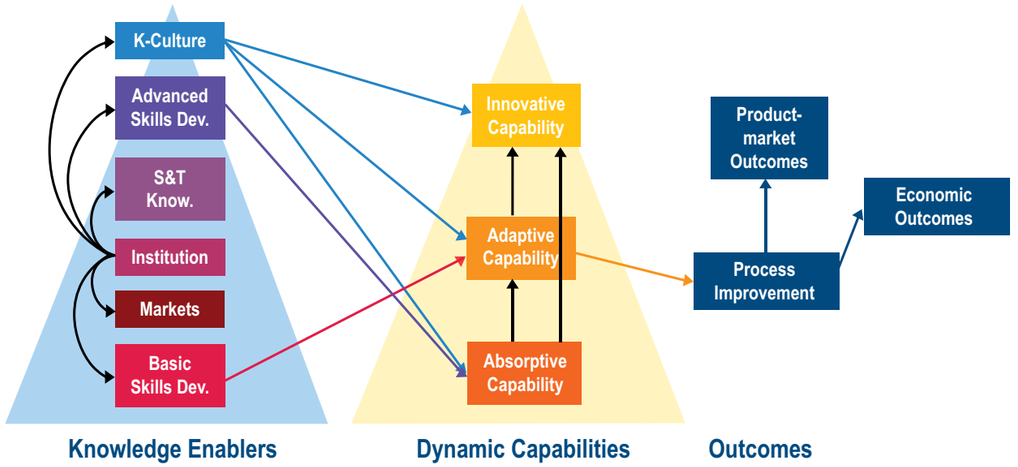


Figure 8.5: Knowledge Ecosystem of the E&E (Final Product) Industry



The E&E (final product) knowledge ecosystem is shown in Figure 8.5; which shows that institutions have a significant impact on all the enablers. Basic skill development was found to have a positive impact on adaptive capability. Advanced skills have a significant impact on absorptive capability. Knowledge culture was found to have significant impact on all three dynamic capabilities. The ecosystem also shows that firms are able to transition from absorptive capability to adaptive capability; and finally transition from adaptive capability to innovative capability. Similar to the E&E (Component), some firms try to 'leap-frog' from absorptive to innovative capability. Only adaptive capability was found to contribute to process improvement and economic outcome. Though process improvement led to product market outcomes; it did not contribute to economic outcomes.

Figure 8.6 shows that impact of institutions on S&T knowledge on adaptive capability was found to be higher for micro-SMEs than for larger firms. Figure 8.7 shows that S&T knowledge on adaptive capability is higher for micro-SMEs than larger firms. However,

Figure 8.6: Knowledge Ecosystem for E&E (Final Product) Industry (Multi-Group-Analysis: Large versus Micro-SME firms)

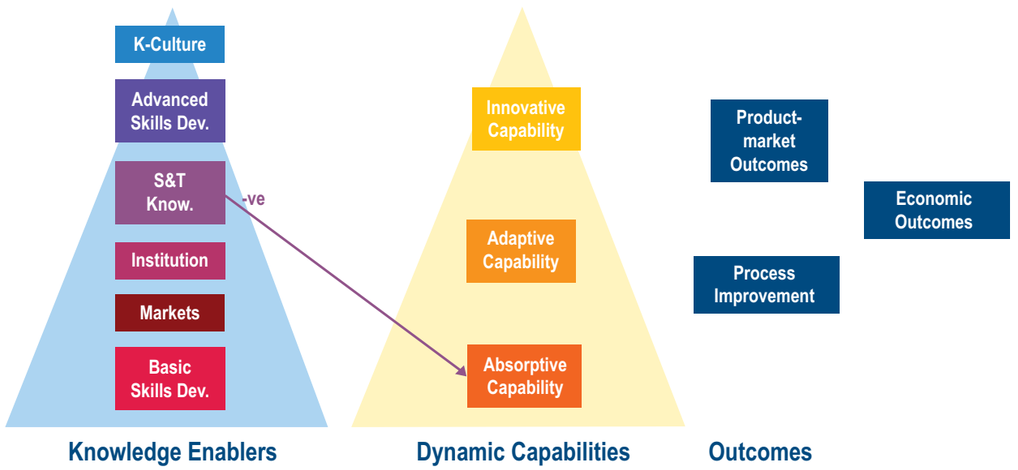
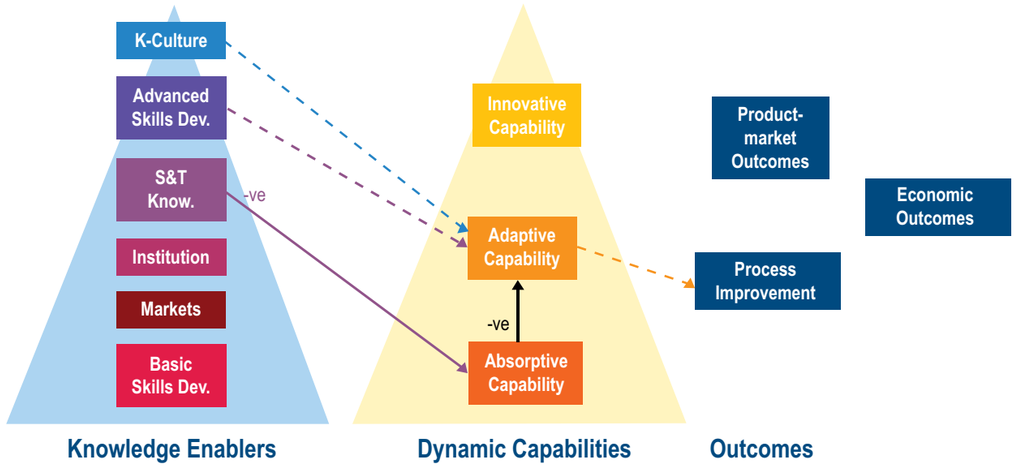


Figure 8.7: Knowledge Ecosystem for E&E (Final Product)
(Multi-Group-Analysis: Foreign versus Component Local)



advanced skills and k-culture on adaptive capability is higher for larger firms than micro-SMEs. The transition from absorptive to adaptive capability was found to be higher for micro-SMEs than larger firms. The larger firms were found to translate the adaptive capability to process improvement more effectively than micro-SMEs.

The impact of knowledge enablers on dynamic capability components, process improvement, product market development and economic outcomes for local and foreign firms are shown in Figure 8.7. The figure shows that the impact of S&T knowledge on innovative capability is higher for local firms than foreign firms. Local firms are also able to translate process improvement into product market development more efficiently than foreign firms. On the other hand, foreign firms are in a better position to translate adaptive capability into innovative capability.

In summary, micro-SMEs tend to be able to generate greater absorptive capability than larger firms. On the other hand, larger firms tend to be in a better position to nurture adaptive capability than micro-SMEs. Further, larger firms have a more significant impact on process improvement than micro-SMEs.

8.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian E&E (Final Products) Industry

Based on the analysis of the knowledge ecosystem of the E&E (final products) industry, the key strengths and gaps of the ecosystem are provided below.

Key Strengths of the E&E (Final Products) Ecosystem:

- Similar to the E&E (components) industry, this industry has received strong support for the Malaysian government to become knowledge intensive. This is in the form of various fiscal (tax deductions and grants) and non-fiscal (access to good infrastructure and talented labour pool) incentives.

- The industry also benefited in the form of technology/knowledge transfer with the entry of leading players from Japan, Korea and US into the domestic market.

- Various research institutes were established to spearhead R&D and innovations among local firms. Among the key initiatives includes the establishment of CREST, MIMOS, SIRIM, Multimedia University and various research centres in both public and private universities.

Key Gaps E&E (Final Product) Ecosystem:

- As in the E&E (Final Product) industry, the development of this industry was rather ad hoc, driven primarily by foreign firms.

- Lack of technical staff and TEVT education ecosystems causes Malaysia to lag behind other pace-setter countries.

- A majority of local graduates in the STEM related areas are users of the technology and not creators of new designs and applications (lack of creative talent in the industry. The best talent is poached by foreign MNCs and seek employment in foreign countries.

- The quantum of R&D spending is relatively low compared to most of the OECD countries in this space.

- Industry-university partnership is relatively weak, hence both institutions are unable to derive the positive spill-over impact.

- Local firms also do not have access to a wider global market supply chain compared to their counterparts from Japan, Korea and the USA.

- Lack of talent and under-investment in technological infrastructure, which means the industry is unable to leap-frog to building innovative capacity that will lead to stronger product market development.

8.4 Recommendations to Improve the Malaysian E&E (Final Products) Ecosystem

Key recommendations to strengthen the E&E (final product) ecosystem are outlined below.

Recommendation 8.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) within the E&E (final product) Industry

The industry is undergoing major transformation due to the Industry 4.0 revolution. Hence, policies and strategies to raise the knowledge content, innovative capability and competitiveness should be aligned to building up the knowledge enablers that will lead the integration of Industry4.0 as core the strategic global positioning of the industry.

Best Practice 7.1: Aligning German High-Technology Innovation Strategy to global trends.

Recommendation 8.2: Enhance the Knowledge Institutional System in E&E (final product) Industry

- *Enhance the Knowledge Institutional System of the E&E (final product) Industry* –government has to play a key role in creating appropriate institutional framework and governance systems that will provide the necessary resources and support system to create a forward look and business friendly environment for transforming Malaysia as a hub for testing and developing new products and service. This will require strong institutions that undertake scientific research, funding agencies, match-making institutions, CoEs and education and training institutes that will work close with industry and industry associations to continuously improve and enhance the industry's market reach for resources, networks and markets.

Best Practice 7.2: German National Innovation Ecosystem

Recommendation 8.3: Incorporate an Innovative Knowledge Approach within the E&E (final product) Industry

- *Facilitate Knowledge Learning & Transfer within the E&E (final product) Industry* – similar to the E&E (components) industry, there should be a framework for firms to gain access to expertise, research facilities and IP/patents from universities and GRIs to develop cutting-edge technology and discoveries that will enhance their competitiveness. The Fraunhofer Institute provide excellent model for strengthening the "triple-helix" to generate greater multiplier effect from the R&D and innovation undertaken by all parties.

Best Practice 7.3: Fraunhofer Institute in Germany

Recommendation 8.4: Develop the Knowledge Capital of the E&E (final product) Industry

- *Incorporate an Innovative Knowledge Approach within the E&E (final product) Industry* – strong focus in STEM related education and research programs. This includes good support for sound basic research and incentives to intensify applied and translational research. A key framework that is widely used in many countries is the Fraunhofer framework that builds strong university-industry partnership model.

Best Practice 7.4 (German Technical and Vocational Education).

Recommendation 8.5: Develop the Knowledge Competency of the E&E (final product) Industry

- *Develop the Knowledge Capital of the E&E (final product) Industry* – there is a strong emphasis on STEM and TEVT educational and training programs from certificate to post-doctoral training.

Best Practice 7.5: The German Technical Education Skills Development Framework of "Berufskonzept' (Occupation) and 'Dualities' (industry-educational institution cooperative endeavour).

Recommendation 8.6: Facilitate Knowledge Learning & Transfer within the E&E (final product) Industry

- In most of the leading countries, the CoE and GRIs are key institutions that enable technology/ knowledge transfer between researcher and industry. Federal funding should be channelled to local universities and GRIs to provide industry access to expertise, research facilities and other resources that will enable them to build their knowledge content and competitiveness.

Best Practice 7.6: The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) – nurturing and strengthening cooperative innovative endeavours in the E&E (final product).

Recommendation 8.7: Strengthen the Knowledge Leverage within the E&E (final product) Industry

- *The Ecosystem has very Strong Knowledge Leverage within the E&E (final product) Industry* – the GRIs and CoEs in the public and private universities can play a key role in the ecosystem to be resource centres for the research community, industry and policy-makers across the nation.

Best Practice 7.7: The Fraunhofer Institute for Applied Solid State Physics (Fraunhofer IAF) – important knowledge resource for all stakeholders in the E&E (components) industry.

8.5 Conclusion

The state of the knowledge ecosystem for the Malaysian E&E (final product) industry was presented in this chapter. One of the key features of the ecosystem is that most firms are only generating process improvement; however, very few are able to translate innovative capability into product market development. In this chapter, we identify key strengths and gaps in the knowledge ecosystem for the Malaysian E&E (final product). Based on the gaps in the ecosystem, several policies and strategies to strengthen the enablers of the ecosystem were discussed in this chapter.

CHAPTER 9

KNOWLEDGE CONTENT OF THE MALAYSIAN RUBBER INDUSTRY

CHAPTER 9
Knowledge Content of the Malaysian Rubber Industry

9.0 Introduction

Malaysia's rubber industry has evolved over the years, undergoing a number of transformations. Overtime it has managed to switch from a purely upstream rubber cultivation industry to a more integrated industry, with strong presence in mid-stream as well as downstream rubber products. Malaysia is internationally recognised as a leader in rubber exports - through strong research and development efforts led by the Malaysian Rubber Board (MRB) it is acknowledged as a foremost authority in natural rubber. With 20% of the world's natural rubber produced locally in Malaysia, the country sits in sixth in terms of natural rubber production after Thailand, Indonesia, Vietnam, China and India. The rubber industry, including natural rubber, rubber products, heveawood products and other rubber (e.g., synthetic rubber, reclaimed rubber, waste rubber, compound rubber and unvulcanised rubber etc.) contributed RM30.30 billion to the national export in 2015 (Malaysian Rubber Board [MRB], 2016). In 2015, the rubber industry registered 722,122 tonnes of natural rubber production, with 676,260 tonnes of dry rubber and 45,862 tonnes of latex rubber (MRB, 2016). About 92 percent of Malaysia's planted rubber comes from smallholders (MRB, 2016).

Due to its strong export orientation, the Malaysian rubber industry is vulnerable to price and currency fluctuations caused by global demand volatility and competition from other rubber-producing nations, such as Thailand and Indonesia. However, global demand for Malaysian natural rubber remains consistently strong because of its superior quality. The shortage in local output is the main challenge for the industry, and significantly limits Malaysia's ability to take advantage of existing market opportunities arising from global demand. Natural rubber production is also subject to weather conditions - adverse weather adds to its volatility in the commodity trade markets. If prices rise beyond certain thresholds, markets respond by switching to alternatives, such as synthetic rubber.

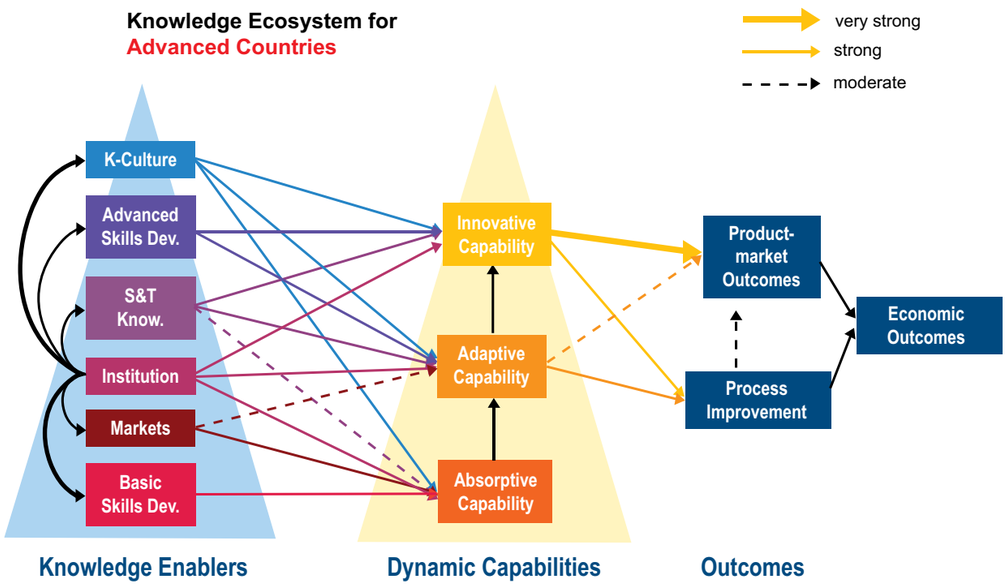
The gradual decline in natural rubber production and export over the past ten years is attributed to the conversion of rubber plantations to oil palm plantations, which offer a better return on investment. Recognising the importance of rubber to Malaysia's economy, the ETP Annual Report (2014) set out to address this decline by providing grants to smallholders to improve the yield on their land by replanting old and unproductive trees. Further measures taken by the Malaysia Rubber Board (MRB) include educating smallholders on good agricultural practices and encouraging the use of higher-yielding breeds. In recent years, natural rubber research has improved the latex yield per hectare with new strains and more efficient methods of rubber-tapping.

Although rubber output has declined, the export value of rubber products remained stable with a slight improvement in 2014, reaching RM 15.17 billion from RM14.6 billion in 2013 (MRB stats). Exports of rubber products for the first half of 2015 rose by 15.1% compared to 2014 (Matrade, 2016). Malaysia remains the world's leading supplier of medical gloves, providing 50% of the global supply. Up to 70% of Malaysia's exported rubber products takes the form of rubber gloves (MREPC, 2015). Malaysia is also the second-largest exporter of latex threads, and a leading producer for catheters and condoms. While much of the raw material is sourced locally, rubber product manufacturers have had to rely on importing rubber to meet the shortfall. Unfortunately, the lower quality of imported rubber leads to inferior products, compromising the global competitiveness of these manufacturers.

9.1 Knowledge Ecosystem for the Rubber Industry in an Advanced Country

The knowledge ecosystem of the rubber industry capturing the intricate relationships between knowledge enablers, dynamic capabilities and economic outcomes is shown in Figure 9.1. The figure shows the rubber industry in advanced economies to be constituted by a richness of links between knowledge enablers, dynamic capabilities and outcomes. It is important to note that the profiles of rubber industries in advanced countries do not feature natural rubber production due to the fact that rubber cultivation prevails mainly in tropical climates. The profile for a rubber industry in an advanced country captures synthetic rubber and a more downstream profile. Knowledge enablers of the rubber industry ecosystem are strong and play a key role in the nurturing and development of strength in dynamic capabilities. Firms in the rubber industries of advanced countries possess relatively strong capabilities which they leverage to create high-level process improvements and new product developments. Ultimately, the effects of these combine to contribute to economically positive outcomes.

Figure 9.1: Complex Relationships in the Rubber Industry in an Advanced Country



The knowledge ecosystem for the rubber industry in an advanced country is characterized by a significant level of development and positive contribution to the national economy. To ensure that companies in the rubber industry remain globally competitive, a considerable level of resources is invested in skills and competencies development, as well as the conduct of ground breaking research through a broad range of initiatives. Through the actions and activities of knowledge enablers, firms in the rubber industry are able to build absorptive, adaptive and innovative capabilities, which help them to improve processes, develop new products and contribute to economic development. Advanced pacesetter rubber industries are characterized by the following:

- *Policies and Strategies aligned with Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Rubber Industry* – Major global trends such as sustainable development, eco-efficiency and smart manufacturing systems that make intelligent products (e.g., Industrie 4.0) define the standards and best practices of natural rubber and synthetic rubber producer firms.

- *Knowledge Institutional System of the Rubber Industry* – Institutional players, government bodies, industry associations and universities come together to draft visions and plans for the industry, identify priority areas of development, and implementation KPIs. Multi--stakeholder buy-in characterizes the seamless execution of policy and plans.

- *Knowledge Capital of the Rubber Industry* – A key concern is the adequacy of human skills to deal with future needs in the rubber industry as emerging trends begin to gain traction. Actions are proactively prepared through needs assessments for advanced skills, and development of training and educational courses. Coverage is extensive, ranging from in-house short course training programs to long-term skill development vis-à-vis the attainment of formal qualifications (diploma, undergraduate, postgraduate) and research programs devised specifically for future rubber industry needs.

- *Knowledge Approach within the Rubber Industry* – Firms in the rubber sector are strongly encouraged to adopt a mind-set of innovation and to align with emerging trends. Firms are incentivized to invest in R&D and use advanced technology to proactively create value-added products for the future. Many extant firms proactively adopt a highly entrepreneurial approach and set out to generate new revenue streams from innovation.

- *Develop the Knowledge Competency for the Rubber Industry* – A clear map of the skill set needed by the industry is complemented by a systematic framework for tracking. These processes are key in addressing the changing landscape of the industry. For example, one can refer to the UK Elasotomers and Rubber Roadmap 2015-2020, which was devised and agreed on by 21 industry players, 6 academic institutions, 8 trade associations and other agencies.

- *Knowledge Learning & Transfer within the Rubber Industry* – Knowledge and innovation networks are formalized to bring businesses, entrepreneurs, academics and funding agencies together to ensure that knowledge is shared. Well integrated frameworks are in place to develop key priority areas and create necessary flows of S&T and R&D; these are connected to ensure the spill-over benefits are reaped by the industry.

- *The Rubber Industry Ecosystem has in place strong Knowledge Leverage mechanisms. Institutions* (government agencies, industry association and educational institutions) play a key role in establishing platforms for and forums on the exchange of information and knowledge to firms in the industry. Specific platforms and infrastructural facilities are created to ensure that all players in the industry, especially entrepreneurial SMEs, are able to access advances in technology, R&D and other knowledge to improve their operations and develop high value-added new products and services.

Example of best practices of the above are illustrated by case studies in the Appendix.

9.2 Knowledge Ecosystem of the Malaysian Rubber Industry

In this section, we provide a brief description of the knowledge ecosystem for the Malaysian rubber industry based on survey data. The survey is comprised of 55 large firms and 77 small firms in a total of 132 firms. Of these, 34 are foreign and 98 are local firms. Figure 9.2 shows the state of development of the knowledge enablers. Most enablers exhibit moderate performance. Notable weaknesses can be observed in institutions and S&T knowledge.

Figure 9.3 shows the dynamic capability components, process improvement and product development in the Malaysian rubber industry vis-à-vis the position of an advanced country. These were measured for both large firms and SMEs; local and foreign firms. Dynamic capabilities, process improvement and product development for advanced countries is significantly higher than that of the Malaysian rubber industry, even though the Malaysian rubber industry is a globally dominant exporter of rubber and rubber products. Foreign firms established in Malaysia are also observed to have slightly higher dynamic capability and product development than local firms. Larger firms are stronger across all dimensions than SMEs.

Figure 9.2: Knowledge Enablers for the Malaysian Rubber Industry

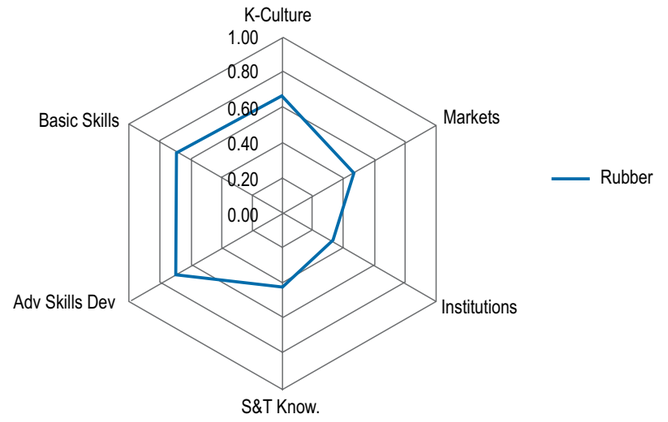
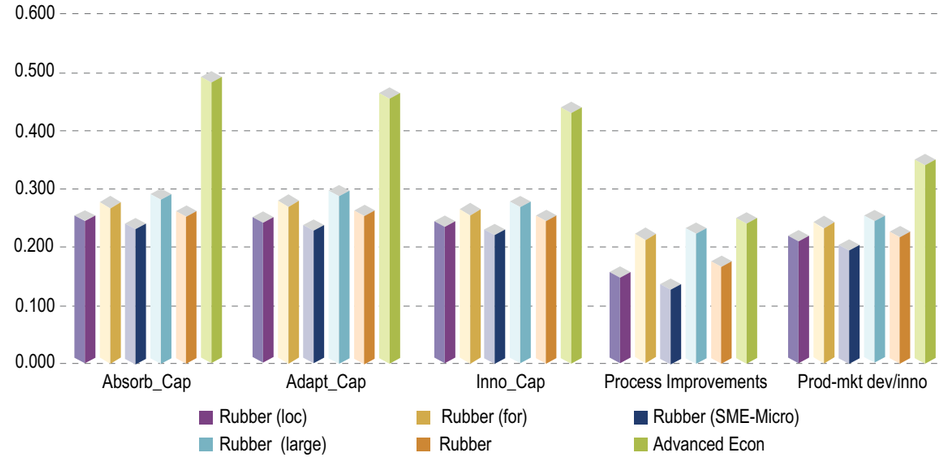
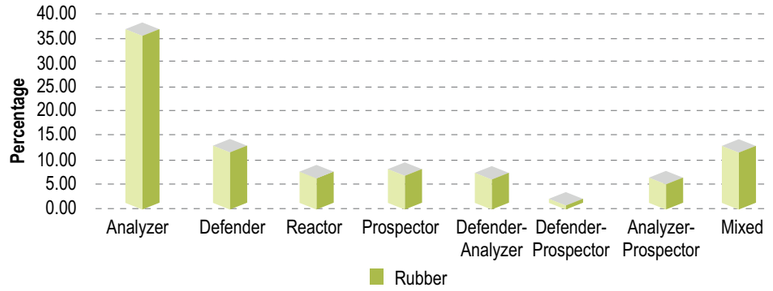


Figure 9.3: State of the Dynamic Capabilities of the Malaysian Rubber Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

Figure 9.4: Strategic Posture of the Firms in the Malaysian Rubber Industry

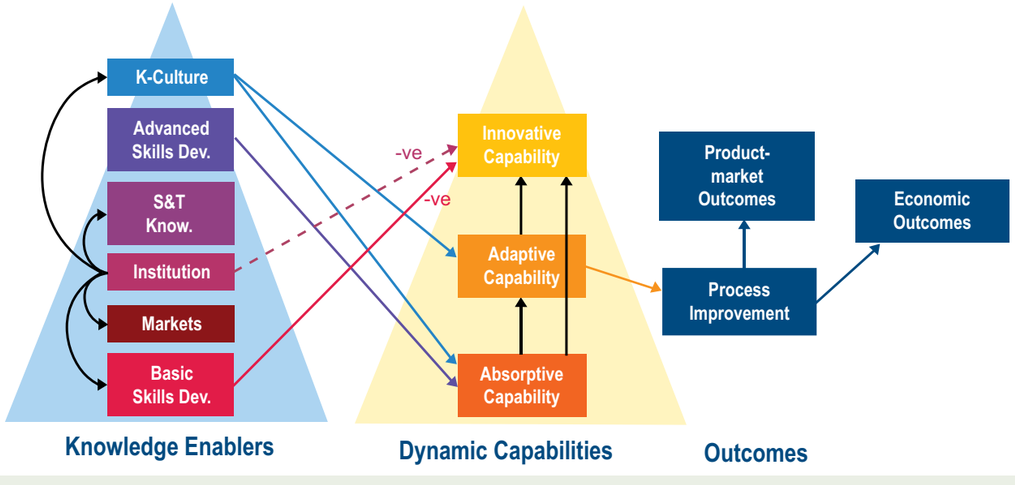


The strategic postures of firms in the Malaysian rubber industry are given in Figure 9.4. The figure shows that a majority of firms are Analysers, followed by Defenders. Prospector firms number below 10%, suggesting that only a small proportion of firms in the rubber industry are active in R&D led innovation.

The knowledge ecosystem for the rubber industry is shown in Figure 9.5. The Malaysian rubber knowledge ecosystem is weak compared to those observed in more advanced countries. Institutions in the Malaysian ecosystem play only an indirect role in developing the knowledge enablers. Worryingly, they have a negative influence in the development of innovative capability, and no significant direct effect on the lower order dynamic capabilities of absorptive and adaptive capabilities. This suggests many firms are not benefitting from institutional provisions for the industry. This is possible when there is significant misalignment between the needs of the rubber industry and the provisions being made by the institutional set-up. Even more problematically, the negative direct effect suggests either institutional encumbrance to the development of higher order dynamic capability or the strong opportunity cost of engagement.

It would appear from the evidence that although institutions play a positive role, they only indirectly strengthen knowledge enablers. In advanced countries, institutions play a strong indirect and direct role in developing firm capabilities. Unfortunately, in the setting of Malaysia other knowledge enablers also fail to significantly surface in the development of dynamic capabilities. Only advanced skills and knowledge culture do so, but for these the effect is directed to lower order dynamic capabilities.

Figure 9.5: Knowledge Ecosystem of the Rubber Industry

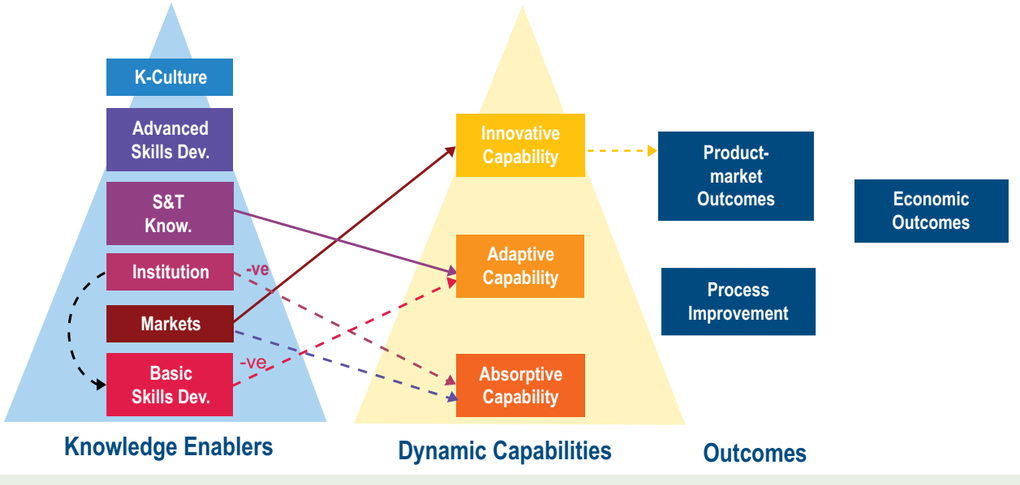


Another worrying facet to emerge from the empirical analysis is the negative impact of basic skills development on innovative capability. This result suggests an over reliance on basic skills to the extent that handicaps firms' innovative behaviour and competence development. This absence of direct positive effects from advanced skills and S&T knowledge in the development of higher order dynamic capabilities is due to a shortage of technically competent staff at the middle and research and development level of operations in the industry. Shortage of technically competent staff hinders rubber industry firms from making any significant refinements and improvements to existing knowledge. Hence, firms are unable to improve the quality of their production processes or develop significant new products.

The evidence suggests a weak knowledge ecosystem which fails to substantially enhance the development of Malaysian rubber to a higher platform. The Malaysian rubber industry nevertheless does create some level of market innovations, but the primary path for doing so is through cost reduction and price competition to drive market penetration and development. The above findings are interesting given that the Malaysian industry enjoys a top 10 position in the global rubber industry in terms of volume of production and export. The findings can be reconciled by the awareness that Malaysia rubber presence remains dominated by the cultivation and growing of rubber as a commodity. A number of bigger players have broken away from this and successfully transitioned to mid-stream and downstream products. Unfortunately, it would seem that substantial numbers have not managed to make the transitions, especially the small holdings. The inability of knowledge enablers in the ecosystem, and in particular institutional enablers to significantly improve the condition of the rubber industry raises structural concerns over the long term viability of smaller players in the rubber industry.

The rubber ecosystem was compared for large and micro-SME firms and the results of the multi-group analysis are presented in Figure 9.6. The results show that institutions play a stronger role in the nurturance of absorptive capability for small firms, whereas large firm absorptive capability is driven to a greater extent by market intelligence. Market intelligence and awareness is also a stronger driver of innovative capability for larger firms. S&T features as a stronger driver of large firm adaptive capability. SMEs on the other hand rely on basic skills to develop adaptive capability. Unsurprisingly, use of basic skills to develop a higher order capability falls far short of what is required for adaptive capability development, and leads to a negative relationship. This suggests SMEs are overly reliant on basic skills and also exhibit higher dependence on institutional support. The results also show large firms to be more adept in the execution of new product development processes. The evidence presents a pressing case for consolidation of the industry in which small players need to grow in size to compete or create strong niche positions in order to survive into the future.

Figure 9.6: Knowledge Ecosystem for Rubber Industry Large versus Micro-SME



9.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Rubber Industry

Based on the analysis of the knowledge ecosystem of the rubber industry, the key strengths and gaps of the ecosystem are provided in this section of the report.

Key Strengths of the Rubber Ecosystem:

- Historically there has been strong support from the Malaysian government to develop the rubber industry as a major revenue earner for the country. This has helped the industry become a major global player in rubber, and helped the industry make a gradual transition from a purely commodity based industry to a mixed base of operations, particularly in the mid-stream but also in end-use products.

- The industry receives significant support from the government in terms of financing for R&D, infrastructure development and capability development (basic and research personnel). As a consequence of this Malaysia hosts leading research centres in rubber cultivation, such as RRIM and LGM.

- Large industry players have the resources and capability to undertake R&D to create new products and services, and a number of the top players have used these to good effect in penetrating end-use markets.

- Key government agencies, such as Malaysian Rubber Export Promotion Council (MRPREC), strongly promote rubber to export markets, and have established a strong reputation for Malaysia in areas such as quality rubber gloves and also medical and healthcare end-use rubber products.

- Global demand for rubber remains high due to the lack of close substitutes. Natural rubber remains a key component of high-end radial tires. However, the tyre industry has been exploring other sources of natural rubber. Guayule (a native strain of Mexico flourishes in arid desert conditions), and Russian dandelion (grows in temperate climate) are two potential sources that are receiving interest and investment for development into tyre grade rubber.

Key Gaps in the Rubber Knowledge Ecosystem:

- Training and skills development is a challenge in the rubber industry. Training and development of basic skills is fundamental to create a position whereby the rubber industry, no matter which level it is at and what part of the value chain it operates in, is able to make a transition to higher value. For instance, even in upstream operations where there is overwhelming use of foreign and low wage labour it is necessary to up-skill to ensure higher grade rubber cultivation.

- At the mid-stream part of the industry value chain, the processed nature of automated rubber operations requires significant long term investment that must be accompanied by appropriate skills upgrading. However, there is a shortage of skilled technical workers to adequately tackle the demands of automated plants and machinery maintenance requirements.

- At the high-value end of the spectrum there is a shortage of staff with sufficient advanced knowledge and skills to reconfigure and apply knowledge for novel and innovative outcomes. Sophisticated chemical engineering technical techniques, deep knowledge of materials and bio-technology are key requirements for success. However, the industry is plagued by the shortage of individuals with advanced skills.

- Businesses, especially local SMEs, do not invest sufficiently in R&D or innovation. Highly talented individuals do not wish to be employed by such firms, and instead look for opportunities in other sectors that allow them the space to experiment and engage in challenging work.

- There is weak market awareness of and response to fundamental social and technological shifts taking place in the industry. For example, there is a rise in social responsibility best practices being implemented by big buyers, such as tyre companies, and the environmentally friendly labelling of tyres in the EU. It is necessary to create a deeper understanding of the emerging sustainability landscape and its disruptive implications for the rubber industry. It is imperative to improve awareness and embed a stronger sense of the protection of the environment as a major driver of end-products of the industry.

- Lack of collective view on the future wellbeing and importance of the rubber industry to Malaysia. Divisions have been created by the widely prevailing stereotype that the rubber industry is a sunset industry. Such parochialism breeds general mistrust among industry players, and dissipates the energy that would be better spent in developing capabilities and establish innovative leadership positions in the global market place.

- Short term outlook of firms at the expense of a long term view of the industry limits firms in the sectors to collectively build a strong global position in the world. The inability of firms in the industry and across the supply chain to come together around key challenges facing the world, such as the environment and sustainability, compromises the industry's ability to build a globally strong brand position.

- Weak collaboration with local universities and international research institutions limits the virtuous cycle of knowledge absorption, creation and application. Strong disconnects within the supply chain and ecosystem of the industry arise due to a lack of appreciation as to how collaboration with universities involved in frontier R&D can lead to high innovation pay-offs.

- Purchase of technologies and machinery from foreign countries without sufficiently explicit clauses for knowledge transfer creates long term dependencies. This dependency constrains the native ability to build process improvements and/ or create novel products through process capability enhancement.

9.4 Recommendations to Improve the Malaysian Rubber Industry Knowledge Ecosystem

The rubber industry is a key contributor to the Malaysian economy. Competition from regional countries, such as Thailand, India and China, has been gradually eroding the Malaysian advantage and share of rubber cultivation, while competition in upstream markets continues to be intense. To ensure the strength and viability of the industry, the following recommendations are proposed to strengthen the knowledge ecosystem of the industry.

Recommendation 9.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Rubber Industry

- Establish a high-level panel consisting of key stakeholders to develop a strategic master plan for the Rubber and Chemicals industry with clear KPIs, resources and outcomes monitoring to raise the innovative capacity and competitiveness in priority areas.

- Develop a holistic Rubber Ecosystem such that it involves the entire supply chain (upstream and downstream) of the industry to ensure continuous support in terms of resources, sharing of best practices, talent and skills development.

- Adopt an integrated ecosystem approach to encourage and attract greater R&D initiatives, innovation and development of new product and technology within the industry.

- Develop a strong partnership between industries to ensure the nurturance of the ecosystem. This will require strategic alignment with downstream industries (healthcare, automotive, tyre, construction, etc.) to create space for positive-sum game partnerships to flourish. Mid-stream rubber players need to connect with downstream sectors (health, auto-tyres, construction, etc.) to understand and exploit high value add opportunities. Mid-stream players also need to connect with upstream rubber plantations to help them provide higher quality and produce at lower cost through the better selection of seed varieties, improved cultivation techniques, etc.

Best Practice 9.1: British Rubber and Polyurethane Products Association Limited (BRPPA)

Best Practice 9.6: European Tyre & Rubber Manufacturers Association

Best Practice 9.7: European Innovation Partnership on Raw Materials

Recommendation 9.2: Knowledge Institutional System of the Rubber Industry

- Establish an effective institutional framework for a more coordinated development of the rubber industry, leveraging on a strong partnership model with all stakeholders (federal & state government agencies, industry associations, industry, community organisations and NGOs) in the industry. A number of actions can be taken towards this end. A select few are elaborated on below.
  - Increase coordination and collaboration between trade associations, government agencies, and universities to drive change in the industry. Trade associations need to continue to play a stronger role in advocating for and championing the change.

  - Continue to promote the Malaysian Rubber industry and its products in key global markets.

  - Industry association should take the lead in sustaining strong investment, especially to support frontier R&D activities.

  - Industry stakeholders to develop programs for organizational development through Kaizen based quality improvement for an automated factory environment and a culture of continuous improvement. A lean six sigma manufacturing culture should be used to drive operational efficiencies, and knowledge sharing.

  - University-Industry Partnerships for Success-University and research institutes must work closely with the leading industry players for leading-edge innovations. KPIs for universities and research institutes need to include explicit metrics for engagement with the industry. Trade associations must monitor and report the number of research projects the industry sponsors with universities (local and international).

Best Practice 9.7: European Innovation Partnership on Raw Materials

Recommendation 9.3: Develop the Knowledge Capital of the Rubber Industry

- Vocational education needs to be re-oriented to ensure there is sufficiency in the basic skills strata to deal with the shift towards automated operations in the rubber industry. This is needed to allow a transition of the industry from a highly labour-intensive industry to one reliant on different types of skill sets required in downstream manufacturing and end use sections of the supply chain. Vocational skills in automated machinery operations and technical understanding of the manufacturing processes, such as dipping, coating need to be readily available.

- Mid-level skills pertaining to a deep understanding of continuous manufacture processes as opposed to simple batch production are fundamental in the rubber processing industry. Development of high level of understanding of GMP, Kaizen and Lean Production and Process Management is key to efficient and high quality manufacture of rubber products, such as gloves, tires, and specialist rubber products.

- Close links with colleges and universities involved in natural rubber sciences, agro-science and chemistry are needed to tap into a pool of graduates who have strong grounding to enter the rubber industry. Colleges and universities located in areas where there is a high density of rubber industry firms need to orient their programs to service skills development and competencies needs of rubber firms in the vicinity. There should be special focus on rubber cultivation, manufacturing processes and rubber end-use knowledge.

- Strong promotion of the diverse range of careers in the rubber industry to assuage negative stereotypes of the industry which appear to prevail in the mind of the general public as well as the younger generation, who are likely to be the future workforce.

Best Practice 9.3: British Plastics Federation- Attracting Talent through Educational Awareness

Best Practice 9.4: RAPRA (Rubber & Plastics Research Association)

Best Practice 9.9: European Skills Association

Recommendation 9.4: Develop the Knowledge Competency of the Rubber Industry

- Knowledge competency requires clear fore-sight as to the nature of development of the rubber industry, and close collaboration between industry and higher education institutions to plan and systematically co-ordinate development. A number of actions, as set out below, can be initiated to facilitate this.

- The extensive work conducted by RRIM (Rubber Research Institute Malaysia) under the aegis of Malaysian Rubber Board (or Lembaga Getah Malaysia, LGM), and Tun Abdul Razak Research Centre (TARRC) in the UK, has created a strong base of R&D and infrastructure for this single commodity. However, this base must be strengthened further to harness new scientific and technological frontiers that appear within the industry.

- Provision of scholarship for research into core areas as well as supporting and enabling areas is required. Competencies in agronomy and genetic engineering, for example to improve the yield of Hevea Brasiliensis are essential. Use of leading edge developments in genomics to genetically engineer novel applications, such as transforming Hevea genes for the production of commercial proteins (pharmaceutical industry) or examining the potential of Research is needed to improve the robustness of the Hevea strand to disease and pestilence attack. Development of high value add enhancements (additives) and processing techniques (e.g. dispersion quality, etc.), requires cross-disciplinary advanced skills and competencies.

Best Practice 9.4: RAPRA (Rubber & Plastics Research Association)

Best Practice 9.2: Murfitts Industries: Riding the Wave of Sustainability

Recommendation 9.5: Facilitate Knowledge Learning & Transfer within the Rubber Industry

- The most effective ways to ensure that knowledge and technology transfer takes place between parties (firms, government agencies and universities) is through the developmentof a 'win-win' model; where industry and universities are provided incentives to work together on programs that align the interests of all parties. A number of steps can be taken:

- Establish a strong industry network with a shared collective vision of overall development so as to enable the set-up of shared facilities or centres to support firms in particular areas and other specialized needs within the supply chain. The sharing of resources will help create positive spill-overs in cross-cutting capabilities that firms can use to benefit each other in a symbiotic manner.

- Foster continuous learning opportunities for SMEs through affordable training programs and courses via universities, colleges, polytechnics, training institutes etc.
- Increase trans-sectoral and transnational mobility to promote international and inter-sectoral acknowledgement of certificates and training courses, including work mobility programmes to encourage skills development.

- Provide incentives to facilitate the set-up and execution of knowledge transfer partnerships. For instance, financial support to universities for R&D, internships and workplace to be given double-tax deductions and access to government grants. Such schemes begin the process of building strong relationships between participants. As parties begin to reap benefits from the cooperation, the partnerships become self-sustaining.

Best Practice 9.4: RAPRA (Rubber & Plastics Research Association)

Best Practice 9.5: British Tyre Manufacturers' Association (BTMA)

Recommendation 9.6: Incorporate Knowledge Approach within the Rubber Industry

Key stakeholders of the rubber industry need to arrive at a stronger collective view as to the benefits of innovation and knowledge, especially as the industry faces increased competition at both the upstream and down-stream end of the rubber supply chain. Steps towards this include:

- Innovation taskforce to evaluate the potential of past technology investments, and administer incremental knowledge improvements and skills extension within the industry in order to extend Malaysian market share in the region and globally.

- Incentives to be developed to help develop a positive mind-set towards R&D investment and long-term outlook whilst simultaneously building and exploiting past resource investments and trajectories for profit.

- Intensify use of Industry4.0 to improve greater efficiency, productivity, interaction and innovation. At the same time, look at the spectrum of rubber end use areas where Malaysia can stretch its current competencies (e.g. extension of health care competencies for greater range of rubber based medical products and devices) and develop stronger niches of advantage by working more closely with current end-market players.

- Put in place policies to encourage foreign and local firms to use locally manufactured rubber materials. This will provide a much needed boost to the industry and the local economy.

Best Practice 9.6: European Tyre & Rubber Manufacturers Association

Recommendation 9.7: Strengthen the Knowledge Leverage within the Rubber Industry

Knowledge in the Malaysia rubber industry is extensive. However, for it to have maximum impact it needs to be collected and disseminated more effectively. Firms in the industry, especially smaller firms, need to be able to make effective use of this through mechanisms that allow them not only access to knowledge but also create infrastructures (e.g. shared labs, etc.) that they can use to realize commercial outcomes. Beyond set-up of infrastructures to facilitate knowledge leverage, a number of steps can be taken to optimize knowledge leverage:

- Identify and invest in niche areas Malaysia can lead at the regional and global level.
- Support SME consolidation to allow economies of scale to prevail. Increases in size should enable a higher level of R&D investment, and hence greater leverage upon the existing base of rubber knowledge to commercial ends.
- SMEs to partnership with large MNCs, such as tyre manufacturers (e.g. Bridgestone, Michelin) to develop specialist applications of natural rubber.
- Develop a programme for sustainable rubber plantations that are able to assure traceability and also ensure consistency of supply to allow uninterrupted operation of upstream rubber industry.
- Nurture talent across a diverse range, especially in specialist areas needed for the future of the rubber industry, e.g. biotech and material sciences.
- Utilize developments in materials, nano and bio-sciences to create high value applications through deeper understanding of specialist high end requirements and understanding of future needs.

Best Practice 9.4: RAPRA (Rubber & Plastics Research Association)

Best Practice 9.8: ERRLAB: a Common initiative to improve support to Small and Medium Rubber Enterprises in Europe.

9.5 Conclusion

This chapter provided valuable information on the state of the knowledge ecosystem for the Malaysian rubber industry. The analysis highlighted some of the key strengths and gaps in the knowledge ecosystem. In particular, the study identified the key knowledge enablers that are strong and have enabled the industry to be a major player. The empirical analysis also identified some of the weaker links in the ecosystem and key reasons for these gaps in the ecosystem. In this chapter, we also discussed key policies and strategies to strengthen knowledge enablers; so as to ensure that the dynamic capability components of the industry are raised to higher levels. Higher dynamic capabilities translate into stronger process improvement and product development; they reciprocally strengthen the knowledge content and economic performance of the industry.

Appendix for Chapter 9

Best Practice 9.1: British Rubber and Polyurethane Products Association Limited (BRPPA)

British Rubber and Polyurethane Products Association Limited (BRPPA) represents the interests of the rubber & polyurethane Industry, covering manufacturers to suppliers of raw materials, services and machinery.

BRPPA is involved in a number of initiatives to help develop the rubber industry:

1. **Development of UK's Elastomer Strategy.** The Knowledge Transfer Network (KTN) works closely with the elastomer community. It held a number of workshops and meetings with members of the community to determine the future outlook and strategy for the elastomers sector in the UK. The outcome of these meetings has been a series of roadmaps.

2. **Initiative on rubber training in the UK - ELTAG (Elastomer Training Action Group)**

For many years now the rubber manufacturing industry in the UK has suffered from the poor availability of technical courses which can be used for the career development. To address this a group of like-minded industrialists, representative organisations and academics in 2014 formed the Elastomer Training Action Group (ELTAG)

ELTAG Aims:

- Generate a range of courses with content of an approved quality and accreditation.
- Re-create a coherent learning pathway in rubber technology that will stretch from NVQ level 2 through to the student's first degree and beyond.
- Especial focus on SME- Competitive pressures on successful companies, usually SMEs, are such that they cannot generally afford to release staff for training and education on a regular day-release basis.

The course developed provides British rubber firms the skills necessary to remain at the forefront in the development and production of high-tech, high value specialised products.

Training Types: Providers

- Short courses- Providers (independents: ARTIS, Polymer Recyclers, etc.).
- Diplomas: Polymer Edexcel BTEC Level 3 Diploma course at South Leicestershire College.
- Long courses (University Colleges- London Metropolitan, etc.).
- Uses a mix of: public and independent providers.

3. Developing SMEs via funding opportunities- Help rubber industry firms become aware of funding opportunities and provide support to secure funds. For example, Royal Society of Chemistry in partnership with Cogent Skills offers grants up to the value of £20,000 to help SMEs in the chemicals sector recruit chemistry undergraduates for a 12-month placement. The purpose of these grants is to facilitate knowledge transfer.

Best Practice 9.2: Murfitts Industries: Riding the Wave of Sustainability

A Suffolk-based manufacturer of rubber granules Murfitts Industries recently was ranked among the UK's top 100 small and medium enterprises (SMEs). The company manufactures rubber granules for use in artificial sports pitches, children's playgrounds, carpet underlay, modified road asphalt and many other applications. Murfitts produces the granules from recycled vehicle tyres at its plant in Lakenheath, Suffolk, processing around 11 million car tyres each year.

The company has developed its own unique manufacturing processes, which has not only resulted in it being able to recycle 100 percent of every tyre, but also ensures that it produces granules of such high quality that they are in demand from the world's biggest sports pitch companies.

The company exports to over 50 countries across five continents.

Recent international projects which utilised Murfitts products include a new pitch for the Tokyo Dome baseball stadium, three fields at CEJU Youth Sports Centre in Belem, Brazil (Part of the 2014 FIFA World Cup Legacy) and the world famous Amsterdam Arena – home of Ajax Football club.

Market Understanding and Investment in Staff

Mark Murfitt, Founder and Managing Director of Murfitts Industries, said: "The recognition of our success in overseas markets is a testament to the hard work and skills of our staff in meeting the needs of customers around the world. We have made significant investment in our plant and processes and are committed to leading the way in both effective recycling and high quality manufacture. Our business is in the rare position of being able to completely remove a waste product from the refuse chain and create something of high value from it."

http://www.murfittsindustries.com/

Best Practice 9.3: British Plastics Federation (BPF)- Attracting Talent through Educational Awareness

BPF has taken proactive actions amid growing concerns over:

- The skills gap
- Where the pipeline is for workers of the future
- Whether the career paths available in the plastics industry are widely known.
- Whether the industry was communicating succinctly the subjects relevant to the future careers of the workers of the future.

Launched "Polymer Zone"

To ensure the pipeline is being filled BPF took action to change the perception of the industry by supporting schools, offering career advice and investing in workplace training.

It developed 'Polymer Zone' as a vehicle to support teachers to help children and young people to learn about why plastics are important as part of the curriculum. It has established a network of polymer sector 'Ambassadors', who visit schools and give students an insight into jobs and the wider polymer industry.

Polymer Study Tours are used to educate teachers on the science, technology and applications of polymers to provide information and create interest, which - it is hoped - will promote recruitment into the industry via the education system.

www.polymerzone.co.uk

Best Practice 9.4: Rubber & Plastics Research Association (RAPRA)

The RAPRA provides immediate and longer term technical support needs to the industry.

Technical Support provided includes:

1. Universities- RAPRA uses University Partnerships to extend its R&D capabilities that can provide access to the latest equipment and specialist academic expertise.

   The RAPRA university network consists of:
   - UK's largest single-university academic network in the field of Polymer Science.
   - A collection of state of the art and cutting edge equipment not available anywhere else in the UK.

The RAPRA universities network provides:

1. **Access to Advanced Skills and Knowledge**

   - Highly skilled technical experts with years of analytical science experience in problem solving, project management, research into new and innovative materials, method development and the exploitation of those materials for commercial gain.
   - Internationally-leading contributions to research in Advanced Materials and Manufacturing, Biomaterials and Healthcare, and Electronics and Photonics.
   - World leading advanced materials research in the development of advanced polymers and composites and high performance ceramics.
   - Access to one of the largest groups of polymer expertise anywhere in the world. Leading providers of continuing professional development training in Polymer Science and Technology for industry.
   - Research in adhesive bonding and pre-treatment of metals and alloys with particular application to the transport industry. Research focus on Microengineering, sustainable energy, and aerospace engineering, nano-composites, and next generation composites.

2. **Access to Commercial labs**

   - Provides a network of commercial labs ranging from small unique facilities to multi-site, multi-national companies, which enables RAPRA take the enquiries it receives via its Polymer Helpdesk and direct them to the very best providers.
   - RAPRA commercial labs have a dedicated workforce with years of experience and passion for problem-solving, optimising production, working on new developments and in some cases training staff in the fields of polymers and processing.
   - The areas of polymer science covered by these labs range from basic testing of materials to cutting edge cryogenics, from research on innovative new materials to the genomics of latex and from sealants and adhesives to the investigation of the very smallest particles to establish cause and effect of failed products and parts.

3. **Access to Infrastructure**

   - Scanning Electron Microscopy, (SEM) used for the analyses of the surface of materials.
   - X-Ray Diffraction which can be used for investigating crystalline material structure, including atomic arrangement and size.
   - Thermal Analysis including such techniques as Differential Scanning Calorimetry (DSC) used to determine the Glass Transition Temperature of a polymer, which is useful if you need to know if your product is going to shatter or become malleable under normal usage depending on the environment it is performing in.
   - Dynamic SIMS: (UK's most powerful Ion Mass Spectrometer, used for measuring chemical structures derived from mass-measurements, at the atomic or molecular level).
   - FT-ICR: (UK's most powerful Mass Spectrometer – applications in complex chemistries, drug and medicine discovery).
   - Solid-State Nuclear Magnetic Resonance: (UK's most powerful NMR spectrometer, used for structure determination and chemical reaction process modelling at atomic measurement resolution).

4. Working closely with Government

- RAPRA contributes to the European and UK strategy for investment in infrastructure geared towards promoting innovation in the industry. It is at the forefront of exerting influence about where and how the investment of billions of euros and hundreds of millions of pounds is made.
- As a member of the Polymer Industry Advisory Group, RAPRA advises the Materials Knowledge Transfer Network (KTN) on current and future innovation investment priorities as perceived by industry. The KTN reports directly to INNOVATE UK (formerly the Technology Strategy Board) which controls the total UK Government Innovation Budget.

- Technology areas that stand to benefit from this investment include renewable energy, future cities, advanced materials, satellites, digital technologies and healthcare. All areas where there is significant opportunity for the increased use of polymer materials.

5. Address Skill Shortages

- In addition to funding research and development of innovative new products and processes, successive UK Governments have recognised and tried to address the chronic shortage of skilled and experienced scientific and technical staff available to UK companies.

- By working with COGENT the Sector Skills Council for the Process Industries, RAPRA is a significant industry voice. RAPRA has assisted in the formation of the National Skills Academy and continues to highlight opportunities for upskilling current staff and recruiting in science and engineering at all levels.

- The role of RAPRA, as a relevant trade association, has been clearly recognised by European and UK Governments as a valuable voice representing the needs industry, especially small and medium-sized enterprises (SMEs).

6. Industry Networking and Knowledge Sharing

- Members of RAPRA have access to a comprehensive technical network in supporting firms' R&D. Included in this is a very active and fertile community environment that, by its nature, stimulates innovation.

https://www.rapra.org/approach/industry-bodies/

Best Practice 9.5: British Tyre Manufacturers' Association (BTMA)

The British Tyre Manufacturers' Association (BTMA) supports and promotes the interests of tyre manufacturers supplying the UK market from factories in Europe.

BTMA engages actively with government ministers, officials and enforcement agencies to progress issues ranging from road safety to the environment and from international competitiveness to employee health and safety.

BTMA is a founder member of the Tyre and Rubber Industries Safety Action Group (TRISAG) that exists to advance the standards of health and safety in the industry through dialogue between the trades unions, employers and the Health & Safety Executive.

Through its work with TRISAG and with individual members BTMA:

- Collaborates to ensure a safe and healthy working environment in the industry

- Shares industry best practices and supports the production of authoritative guidance

- Supports appropriate research

- Involved in regulation impacting the industry

BTMA also support its members to reduce the environmental footprint of their UK factories though improved energy efficiency under a Climate Change Agreement.

BTMA co-operates actively with other UK tyre industry trade associations though the Tyre Industry Federation, industry trades unions and the Health and Safety Executive though the Tyre and Rubber Industries Safety Action Group. For instance, BTMA works in close collaboration with the European Tyre and Rubber Manufacturers Association and the European Tyre and Rim Technical Organization.

http://www.btmauk.com/

Best Practice 9.6: European Tyre & Rubber Manufacturers Association

ETRMA represents 4,200 companies in EU25, employing 360,000 individuals with a turnover exceeding € 49 b while exports represent more than €6.3 b. The product range of its members is extensive from tyres to pharmaceutical, baby care, construction and automotive rubber goods.

ETRMA members are:

- Apollo Vredestein, Bridgestone Europe, Continental, Cooper Tire, Goodyear-Dunlop Tires Europe, Marangoni, Michelin, Nokian Tyre, Pirelli Tyre and Trelleborg Wheel Systems.

- National rubber manufacturers' associations of Belgium (Febelplast), Finland (RMAF), France (SNCP), Germany (wdk), Italy (Federazione Gomma Plastica), The Netherlands (NVR), Portugal (APIB), Spain (Consorcio) and Sweden (SGI). United Kingdom (BTMA) is an affiliated member.

ERTMA plays a number of key roles:

- Capability building role- enhancing the competitiveness of companies is its dominant role.

- Regulatory role- Every act of legislation has an impact on industry competitiveness.

  - ETRMA in Brussels continues to deploy the necessary steps to put forward the industry points of view, anticipating and assisting the EU institutions in their sophisticated regulatory steps and pushing for free trade and better market access.

  - The cumulative effect of legislation on the manufacturers can not be underestimated – ranging from requirements on production processes [Emission Trading Scheme III], through the chemicals used [REACH], to end of life management of products [Producer Responsibility; Resource Efficient Europe].

  - Tyres are increasingly facing trade barriers stemming from legislation of countries beyond the EU.

Coordination role-

- ETRMA activities focus on representation, co-ordination, communication, promotion and technical liaison.

http://www.etrma.org/

Best Practice 9.7: European Innovation Partnership on Raw material

Natural Rubber is an essential raw material for the European industry and one for which Europe is totally dependent on imports.

Consequently, the European Innovation Partnership on Raw Materials (EIP on Raw Materials) was launched in February 2013 with the objective of securing a sustainable supply of raw materials.

Aim: Provide Europe with enough flexibility and alternatives in the supply of important raw materials by becoming the world leader by 2020 in exploration, extraction, processing, recycling and substitution.

EIP is expected to trigger innovation mechanisms to achieve its objectives. These include new policy tools at the EU level and innovation-friendly regulatory conditions at Member States level to support the development of innovations- both technology-based and nontechnology-based. Investing in people (skills) and in stimulating excellence in the science base is at the core of the initiatives of the Partnership together with the promotion of targeted standardisation and public procurement instruments.

EIP brings together Member States and other stakeholders (companies, associations, NGOs, researchers etc.) to develop joint strategies, pull together capital and human resources and ensure the implementation and dissemination of innovative solutions within Europe.

http://ec.europa.eu/enterprise/policies/raw-materials/innovation-partnership/index_en.htm

http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=eip

Best Practice 9.8: ERRLAB: a Common initiative to improve support to Small and Medium Rubber Enterprises in Europe.

- European Research and Rubber Laboratories (ERRLAB) is a European informal network of laboratories for research and testing in rubber applications, established by France, Germany and Italy benchmark rubber laboratories (LRCCP, DIK, CERISIE respectively), with the support of the rubber industry National Associations (SNCP, WDK, Assogomma respectively) and the European Tyre and Rubber Manufacturers Association (ETRMA). It has more than 100 PhDs, engineers and technicians in highly specialized fields of rubber.

- ERRLAB's objective is to share resources and expertise in order to provide an ever better and complete technical service to the European rubber manufacturing industry, with a special attention to small and medium enterprises, in the field of Environment, Health and Safety studies, Research & Development, testing and certification.

- Networking and cooperation between industry and research community supports the scientific and technological development of the rubber sector and the strengthening of the European Rubber Industry towards the challenging safety and environmental requirements.

- It is constituted by 3 Labs, 3 National Associations and 1European Organization.

http://www.errlab.eu/

http://www.etrma.org/activities/errlab

Best Practice 9.9: European Skills Association:
European Skills Challenge: Skills miss-match, from challenge to opportunity

- In its 2015 Management Plan the EU community noted "Severe unemployment coexists with an ageing workforce, shortages of skilled workers and skill mismatches". As a result, the European Automotive Skills Council was launched to identify the drivers of change and the working profiles of tomorrow. From the study it became clear that the industry alone cannot succeed in turning this challenge into an opportunity. Institutions at both national and EU level and educators have a key role to play.

- The capacity of the European rubber industry to preserve its manufacturing base and jobs in Europe depends on its capacity to increase the competitiveness through innovation, as well as swift and smooth adaptation to change. From the point of view of employment, this means jobs transformation in terms of new tasks, new skills profiles and new working arrangements. The reinforcement of the competitiveness of the sector constitutes the only way to preserve and develop employment in the EU in the long term. Two areas of need were identified:

1. **The Generational Challenge** - The skills of those who are retiring are a rare commodity on the labour market. Furthermore, the sector no longer seems to attract young talents as successfully as other competing fields, such as electronics and telecommunication.

2. **Keeping Up with the Innovation -** The types of jobs available in the sector are shifting towards highly trained and specialised workers with polyvalent tasks: less repetitive and more "machine tune and control" skills. Furthermore, the industry demands for combined engineering specialisations –ME CHEM TRONIC, PhDs in Chemistry or Material Science, Electronics &Telecommunication, Computer Science, Informatics, Operations Management, Mechanical Engineering, Industrial Engineering, Production Planning, Distribution, Supply Chain & Logistics, Business & Strategic Planning, Industrial Technology etc.

http://www.euautomotiveskillscouncil.eu/

http://www.etrma.org/activities/the-skills-challenge

References

1. Malaysian Rubber Board [MRB]. (2016). *Natural Rubber Statistics 2016*. Retrieved from http://www.lgm.gov.my/nrstat/nrstats.pdf

2. ETP Annual Report (2014). *Annual Report 2014*. Retrieved from http://etp.pemandu.gov.my/annualreport2014/

3. Malaysia External Trade Development Corporation [MATRADE]. (2016) *Transport Equipment*. Retrieved from http://beta.matrade.gov.my/en/rss-matrade/55-foreign-buyers/industry-write-up-products/352-transport-equipment

4. Malaysian Rubber Export Promotion Council Home [MREPC] (2015). *Industry Overview*. Retrieved from http://www.mrepc.com/industry/industry.php

CHAPTER 10

KNOWLEDGE CONTENT OF THE MALAYSIAN PLASTICS INDUSTRY

CHAPTER 10
Knowledge Content of the Malaysian Plastics Industry

10.0 Introduction

Plastics is a ubiquitous industry. Plastic products touch human lives in diverse ways. The use of plastics has grown twenty fold over the last half century and its use continues unabated. Around 85% of the world's total plastics production is concentrated in Europe, USA and Asia. Asia holds around 45% of the global market share, USA and Europe together hold 40%, and the remaining 15% is spread among the rest of the world.

Plastic products are used in almost every industrial and consumer sector because of their low cost and functional versatility. The plastic industry is an enabler of diverse industries, such as aerospace, maritime, transport, construction, healthcare, white goods, energy generation, military and packaging. In a number of industries, it has been a transformative enabler of innovation and change. For example, plastic use accounts for about 50% of the weight of the Boeing Dreamliner; and advanced development in bio-plastics is leading to novel uses in medicines and human well-being, such as dissolving stents for heart patients.

The plastics industry has strong multiplier effects, and features as a strong driver of innovation across a wide range of industries. In Europe the plastics industry directly employs over 1.45millon people, with more than 60,000 companies, most of which are SMEs. Estimates suggest a multiplier effect of 2.4 in GDP and almost 3 in jobs (The European House of Ambroselli Study, 2013). The plastics industry is one of the most innovative sectors in the EU, capturing 1 in 25 patents submitted to the EU between 2003 to 2012. This is unsurprising given the discussion of the dynamic capability knowledge ecosystems of pace setter firms in leading benchmark countries, such as USA, Germany and UK. Pace setter firms in benchmark countries, both large firms and SMEs, have a significant economic impact through their ability to innovate and establish leading positions in the high value end of the market spectrum.

Plastics firms in the US have received fresh impetus and become re-energized with the advent and growth of Shale gas. This has enabled to them to gain a significant cost advantage through low raw material inputs, and helped them to bolster their market positions even further. In face of this, even world class companies in Europe are feeling the competitive bite as price pressures begin to squeeze margins at the top end.

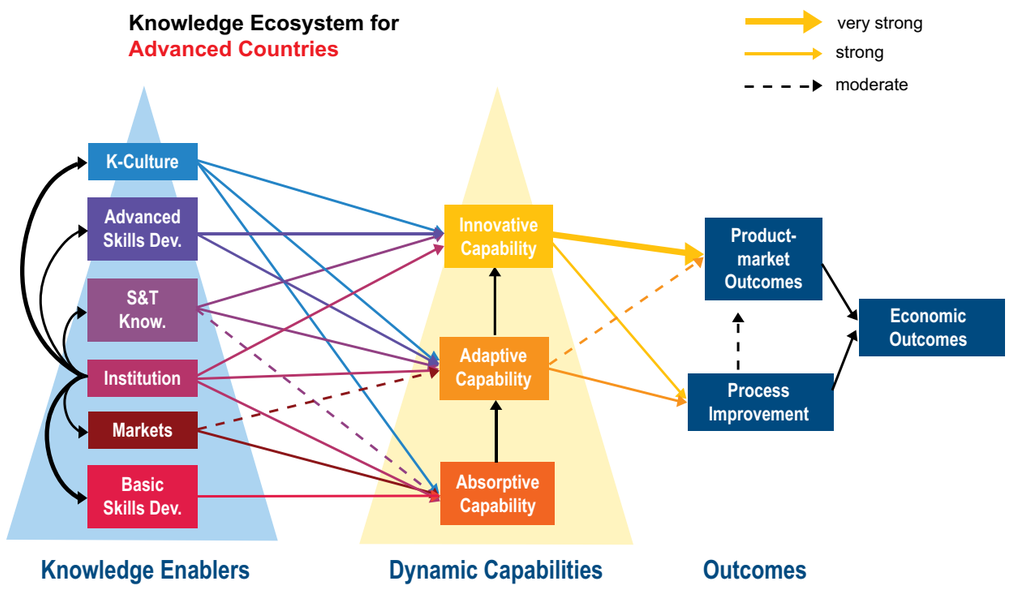
With the intensification of competitive pressures, it becomes imperative for firms to build strong positions by moving up the knowledge and innovation value chain. In this chapter, we assess the knowledge ecosystems of the plastics industry using the MYKE-III knowledge ecosystem model for a sample of 234 firms operating in Malaysia. From the sample, 65 are large firms, 169 are SMEs, 179 are local firms and 55 are foreign.

The chapter is organized as follows: in Section 10.1 a description of a knowledge ecosystem of plastics industry in an advanced country is provided. In Section 10.2, we provide a description of the knowledge ecosystem for the Malaysian plastics industry. In Section 10.3 the report grapples with the key strengths and gaps in the Malaysian plastics industry knowledge ecosystem. In Section 10.4, key recommendations to improve the knowledge ecosystem of the Malaysian palm oil industry are provided before concluding in Section 10.5.

10.1 Knowledge Ecosystem in an Advanced Plastics Industry Economy

The relationship between the knowledge enablers, dynamic capabilities and economic outcomes for advanced countries is shown in Figure 10.1. The ecosystem shows richness in the knowledge enablers such that they are able to nurture strong development of the three components of the dynamic capability. Institutions (government agencies, trade associations and universities) play a dual role in ensuring other enablers support dynamic capability buildings through strong nurturance of these enablers and directly influencing the dynamic capability components. Key components of knowledge ecosystem for the plastics industry in an advanced country are discussed.

Figure 10.1: Knowledge Ecosystem for the Plastics Industry in an Advanced Country



❑ *Knowledge Context*

Many of the advanced countries with pace-setting plastics sectors are driven by carefully promulgated policies based on a detailed assessment of key future trends and directions. Armed with a depth of understanding regarding the likely development trajectories and pressing issues and challenges facing the plastic industry, advanced countries put in place yardsticks and standards, regulations and policies to guide the industry. The plastics industry is shaped by a number of emerging issues, such as responsible consumption patterns and heightened sense of environmental responsibility; volatility in raw material inputs as a consequence of political instability as well as emergence of alternative raw materials, such as shale oil, and advances in manufacturing and materials science. This necessitates inputs from a range of experts and institutions to ensure there is an availability of knowledge to address key emerging issues, such that firms in the industry have in place systems and processes to meet environmental, health and manufacturing standards as well as other strategies to mitigate both internal and external risks to the industry.

Through a process of strong adherence and compliance to global best practices, standards and policy led guidance and support, firms in the advanced countries nurture a knowledge culture that develops absorptive, adaptive and innovative capabilities of firms and workers; hence promoting a culture of continuous improvement and innovation.

See ***Case-Study 1 and 5: British Plastics Federation and American Chemistry Council's Plastic Division*** for insight into its role in guiding the development of the plastics industry and promoting global competitiveness through a range of initiatives.

❑ *Knowledge Institutional Systems*

Highly coordinated institutional players feature as a key component of the knowledge ecosystem of plastics industries in many advanced countries, enabling firms to drive continuous improvement and innovation. In these countries, government agencies, industry associations and educational institutions work closely in multi-stakeholder partnership to develop and execute long-term and short term strategic plans for the systematic development of the plastics industry. These strategic plans contain the implementation strategy and tracking performance indicators to monitor knowledge development over targeted time period. The plans define priority areas of research and development to enable the industry to intensify process improvement and innovation. The milestones of the programs are tracked on a regular basis and outcomes communicated in an open and transparent manner on a regular basis. Reviews of the strategies, policies and milestones are undertaken regularly to ensure that plans align with any changes taking place in the industry environment. In this manner the plastics industry development is aligned with the objective of transforming the industry into a knowledge-intensive one.

Refer to ***Case-Study 7: Australia Government's Approach to Chemicals and Plastics Industry*** on how it provides an extensive range of support and formulates strategic plans for the development of the chemicals and plastics sectors.

❑ *Knowledge Capital*

In most advanced countries, the plastic industry features as an important enabling industry feeding into wide range of sectors. As such, significant resources are invested to develop human capability and competencies to ensure that the industry is able to act not just as a feed of basic raw inputs but helps drive innovation and improvement of recipient industries. To ensure this takes place, advanced countries pay considerable attention to build human capital that is able to deliver on the current and future needs of industry. Possessing this feature the knowledge ecosystem of the advanced countries exhibits the strong impact of basic skills and S&T knowledge on absorptive capability; and S&T and advanced knowledge on adaptive capability and innovative capabilities. These countries engage in a range of skills development initiatives, such as providing a wide range of training, workshops and courses to help the workforce to up-skill and continuously improve their skillset. Young children and the youth are also encouraged to engage with the industry, in order to raise their awareness and attract them to work in the plastic industry.

Refer to ***Case-Study 4: EU Modernization of TVET*** shows the approach taken to ensure that key skills, competencies and practices are developed in the plastics industry workforce.

❑ *Knowledge Competence*

Plastics industries of advanced countries are highly focused on the development of firm and individual level competencies for long-term competitive success. They take a future orientated outlook and proactively manage development of competencies. Numerous courses and training programs (certificate, diploma and tertiary qualifications) are in place for the workers to develop professional expertise. These countries take a holistic perspective to skills training and continuous upgrading of the knowledge base of the workforce. Skills competency frameworks are in place and range from basic skills to post-doctoral training to meet the full breadth and depth of trained personnel needed to ensure the industry remains knowledge intensive and competitive.

Refer to ***Case-Study on Plastics Institute of America and Thailand's Approach to Bio-plastics*** *on how skills and competencies can be mapped out to build competitive strategies and position for market success.*

❑ *Knowledge Learning and Transfer*

A key feature of the knowledge ecosystem in advanced countries is in the strong existence of partnerships among government agencies, industry and educational institutions to encourage knowledge learning and transfer. These enable educational institutions to align courses to needs of industry. Additionally, partnerships also enable university R&D activities to directly benefit industry, especially SMEs who may not have the relevant expertise and R&D facilities to undertake leading-edge research. This helps enhance process improvement and new product development. An example of best practices in fostering strong university-industry partnership model can be observed in ***Case-Study: Australian Government's Approach to the Chemicals and Plastics Industry.***

❑ *Knowledge Approach*

In many advanced countries strong collaboration between industry, universities, Government Research Institutes (GRIs) and Centers of Excellence (CoEs) provides opportunities to create fundamental advances as well the strategic development of the plastics sector through application of scientific and technological advances. A knowledge approach that is gaining immense popularity is the university-industry engagement modelled after the Fraunhofer philosophy. This philosophy provides a systematic and targeted approach in generating new breakthroughs and innovations that help enhance process improvements, product development and open up new revenue streams.

Refer to ***Case-Study 8- Australian Government DIIS, Science and Research Priorities.***

❑ *Knowledge Leverage*

A key challenge faced by companies is to harness the maximum effect of the knowledge they possess or the opportunity that presents itself. At times, companies are unable to leverage knowledge because they are unaware of the opportunities. In other instances, small players are unable to take advantage of opportunities since large scale investment (in capital assets and equipment or market development and penetration) is beyond their financial means. Advanced countries address these challenges by providing access to information as well as on support services through a variety of mechanisms. Advice on regulations and best practice, access to specialist expertise, research facilities, networks and other support services is made available through a few primary pathways. The first channel is through various government agencies, which have up-to-date and comprehensive online resources for the plastics industry and provide a range of help-desk and consultancy services to the plastics firms. Second, key universities, colleges and institutes act as nodes of knowledge and provide access to infrastructure as well as research expertise and advice. Industry federations form the third channel to facilitate this.

Refer to ***Case-Study on Ireland Gateway, as well as British Plastic Federations.***

The analysis of the knowledge ecosystem of the plastics industry from the perspective of an advanced country suggests that the knowledge environment, institutional framework for strategic development (knowledge ecosystem), knowledge capital, knowledge competencies, knowledge learning & transfer mechanism and knowledge leverage programs are key drivers in the development of the dynamic capability of the industry. Together they combine to form the enabling conditions for the development of the dynamic capability building blocks that drive process improvement and innovation within the ecosystem.

10.2 Knowledge Ecosystem of the Malaysian Plastics Industry

In this section, we provide a brief description of the knowledge ecosystem for the Malaysian plastics industry based on survey data. The survey is comprised of 65 large firms and 169 small firms, giving a total of 234 firms. Of these 55 are foreign and 179 are local firms Figure 10.2 show the state of development of the knowledge enablers. All enablers are performing at the moderate level, with the exception of institutions, which score below 0.5.

Figure 10.3 shows the dynamic capability components, process improvement and product development in the Malaysian plastics industry and compares it to an advanced country. Dynamic capability components, process improvement and product development were measured for large, SMEs, local and foreign firms. The dynamic capability, process improvement and product development for advanced countries are observed to be significantly higher than that of the Malaysian plastics industry. However, large Malaysian plastic firms exhibit similar dynamic capability and product development to that

Figure 10.2: Knowledge Enablers for the Malaysian Plastics Industry

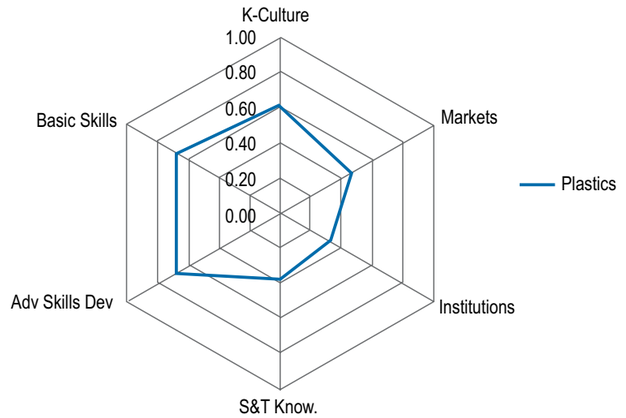
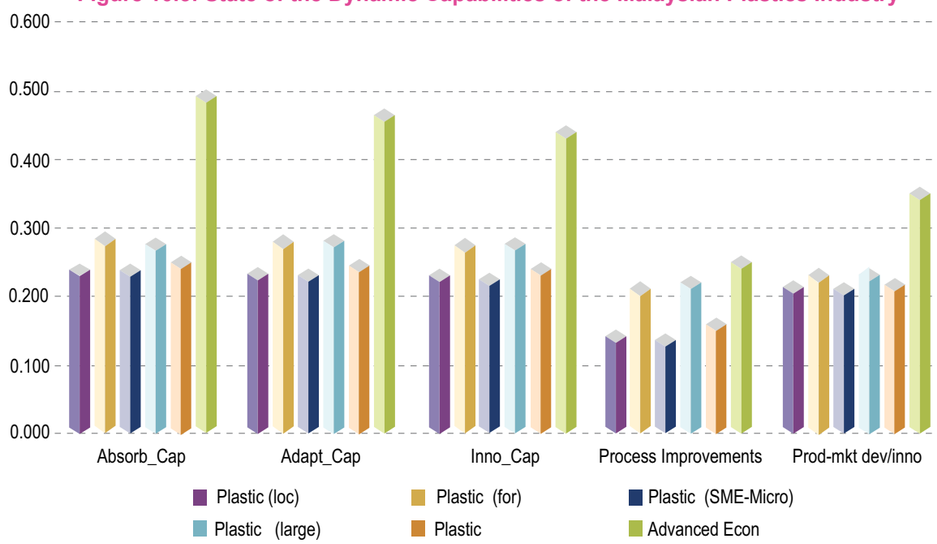


Figure 10.3: State of the Dynamic Capabilities of the Malaysian Plastics Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

of foreign firms operating in the Malaysia. However, in all cases, SME do not fare as well as their larger counterparts.

The strategic postures of firms in the Malaysian plastics industry are given in Figure 10.4. The figure shows that a majority of firms are Analyser, while the next group comprises of Reactors. Defenders are the next largest group followed by the Prospector group. Prospector firms are below 10%, suggesting a low level of engagement in undertaking path-breaking R&D and innovative effort.

Figure 10.5 shows the Malaysian knowledge ecosystem for the plastics industry to be very different from that of the ecosystem of pace-setter leading countries. It is much weaker as can be evidenced by the fewer linkages as well as the nature and directionality of these linkages.

Basic skills in Malaysian plastics industry do not influence the nurturance of dynamic capabilities. In the pace-setter advanced countries, basic skills are involved in the development of the dynamic capability foundation. The reason for the lack of impact is largely due the difference in basic skills. In Malaysia, basic skills are often characteristic of individuals who are not only low skilled, but often are also foreign workers.

Malaysian firms see little value in training these low-skilled workers, who they consider to be part of a highly transient immigrant workforce. In sharp contrast, pace-setter country firms perceive workers at the shop-floor in a very different light. These workers are developed over time to become skilled operators through specific in-house and external vocational training. Training and development at this level is considered important to retain individuals with on-the-job experience. By providing them a route up the organization hierarchy, training and development creates scope for these individuals to contribute to process improvements and even product improvements through a range of initiatives, such as Kaisen. The value of these skills level increases as the firms in advanced country moves to more automated operations. The nature of basic skills in this type of setting is very different from the physical setting of hard manual work in the Malaysian plastics industry.

Multi-Group Analysis to scrutinize difference between large and SME firms in Malaysia suggests no difference, indicating that both suffer from the same deficiency in their basic skills (see Figure 10.6). In other words, there is an over reliance on low wage and lowly skilled labourers, especially foreign labour. Very little attempt is made to invest in the long term skills of these individuals. Unsurprisingly, this group of low skilled workers has no influence on dynamic capability building, and these individuals play little role in shop-floor level improvements.

Markets play an important role in directing firms to align to customer needs, and are observed as a key driver of absorptive knowledge in firms in pace-setter countries. SMEs in pace setter countries use markets to drive capability building even more than large firms do. In these countries, market intelligence influences SME adaptive capabilities. SMEs quickly adjust their processes and align product development in order to rapidly seize emerging market opportunities. Market intelligence is used very efficiently and effectively to create positive market outcomes.

Interestingly, for the Malaysian industry, in sharp contrast to what is observed in pace-setter advanced countries, market intelligence and close in-depth understanding of key trends fails to significantly influence organizational capability building. Malaysian firms appear to have fixed their focus on particular segments and appear to focus almost all their energy in producing products to service existing needs of the existing clients. They appear to take little note of changing markets conditions. In particular, they are largely unaware of where there may be potential long term opportunities for higher value adding activity. This deficiency in being market-driven does not bode well for the industry.

MGA analysis suggest that SMEs are better at market sensing than the larger firms. Larger firms appear to be sluggish in their market intelligence and response.

Figure 10.4: Strategic Posture of the Firms in the Malaysian Plastics Industry

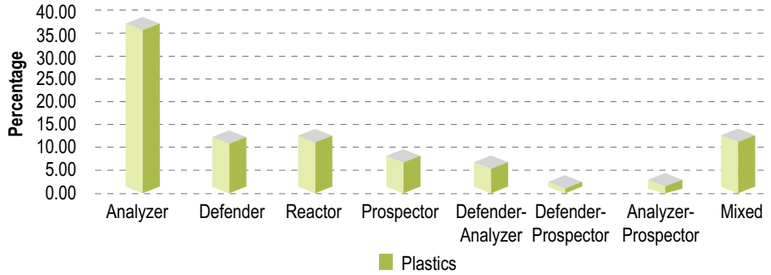


Figure 10.5: Knowledge Ecosystem of the Plastics Industry

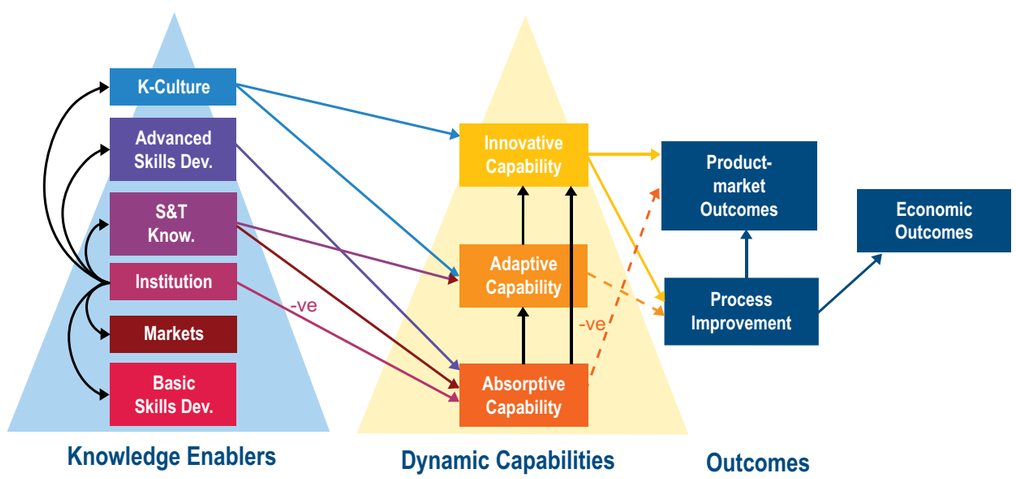
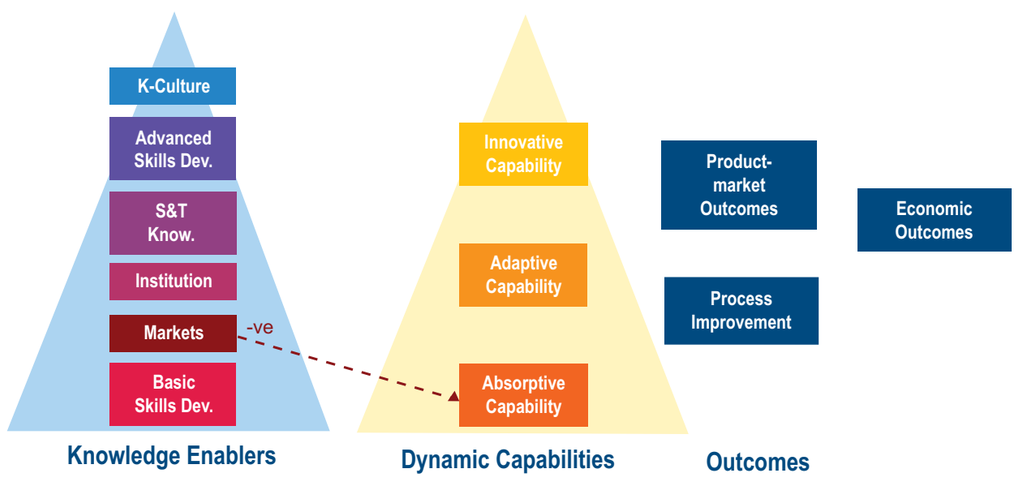


Figure 10.6: Knowledge Ecosystem for Plastics Large versus Micro-SME firms



Institutions are an important enabler in the pace-setter country setting, having direct and indirect impacts on the organizational capabilities. In Malaysia, institutions indirectly influence other enablers but they do not have a direct impact on firms' dynamic capabilities. Worryingly, the only direct effect institutions have is a negative one on absorptive capability. It would seem that in the plastics industry at least, there is a strong disconnect between institutional agencies and firms. There appears to be underlying mistrust and a lack of understanding between the different stakeholder parties, over motives and intentions. As a consequence, the capabilities of firm appear to be hindered by institutional factors, such as a high level of bureaucracy, failure to fully understand industry needs, lack of the appropriate type skills building, and so on. Our MGA analysis shows that this deficiency holds true for both large and small firms.

In pace setter countries, the plastics industry has a powerful voice throughout its industry. In Europe, for example, the European Plastics Association supplies a loud lobbying voice. The EPA commissions major studies on the plastics industry and its future. It works closely with policy making institutions to chart policies for the future development of the industry, as well as being an active player in shaping the future of skills and curriculum development. Additionally, government institutions take a long term view of the industry, recognize its value to the economy and undertake initiatives to protect the long term competiveness of the plastics industry. Institutions see it as an important industry and understand it to be fundamental enabler of a diverse range of manufacturing and distributive sectors. As such, support is rendered through a range of mechanisms from high level strategic planning and fore-sighting, investment in frontier research through to education and development of mechanisms to filter and transfer knowledge into firms.

Pace setter advanced countries invest heavily in S&T knowledge by ensuring that they have a plastics industry ecosystem that is filled with specialist expertise and knowledge through the existence of several supporting institutions, such as universities. Universities and research institutes not only build undergraduate level skills but create highly specialised knowledge by engaging in fundamental research and also provide access to their specialist infrastructure to firms, especially SMEs who do not possess high end R&D infrastructure. For instance, the State of Georgia is serviced by a number of specialist research universities as well as vocational colleges that feed into the S&T knowledge base of plastic industry firms located in the vicinity.

S&T plays a role in the development of firms in the Malaysian plastic industry. However, S&T effort is directed to knowledge absorption and, to some extent, adaptive capability. Large firms and SMEs seem to be similar in using S&T to build absorptive and adaptive capabilities. The major point of difference between Malaysian plastics firms and pace setter country firms is that while Malaysian firms focus strongly on using S&T to build lower level organizational capabilities, the major thrust for pace setters is on building higher order dynamic capabilities. Pace-setter country firms let S&T knowledge guide the development of the internal processes in order to fully leverage S&T to build innovative capability.

Advanced skills of experts, be they bio-scientists, marketing and branding experts, IT specialists, materials and nanotechnologists are key in the endeavour for innovation. Pace-country firms pay a great deal of attention in attracting, developing and retaining such talent through provision of a range of incentives and special packages. These individuals, working in large as well as small firms, are a core ingredient in navigating innovation initiatives to successful outcomes. In large companies, such individuals are provided creative space for experimentation and failure. In small firms they are highly respected and have a strong influence over the firm's directions and activities. In both large and small firms, advanced skills strongly influence development of adaptive and innovative capabilities.

Advanced skills also feature strongly in the Malaysian plastics knowledge ecosystem. However, the nature and path of impact is vastly different. Advanced skills appear to be deployed in the development of absorptive capability rather than higher order dynamic capabilities. It would seem that the Malaysian plastics industry involves its top knowledge personnel in lower-end activities of trying to absorb and make sense of external knowledge rather than develop new knowledge and innovative applications on their own, or to help the configuration of the organization in how to exploit knowledge by melding it to market place opportunities in the form of high value market propositions. This is worrying in that talented individuals are not set challenging tasks, hence they tend to leave for companies that provide better environments for them to develop their careers. Many talented individuals leave the industry either to work in foreign MNCs in Malaysia, or leave the country for attractive opportunities abroad.

Talented staff working in the industry are unfortunately not provided with significant opportunities to extend themselves. Many of the firms do not have the resources or the inclination to spend significantly on R&D; hence, talented individuals are not given the space to exercise their skills. This problem is further compounded by the Malaysian ecosystem not providing sufficient access to research infrastructure and external experts in universities or research institutes. One cause of this is a lack of universities conducting research that extends boundaries of knowledge in areas cognate to plastics and its applications. The inability to attract the right type of talent or retain it once it has joined the industry means Malaysians firms are hampered by the fact that the number of top experts across the need spectrum is small compared to foreign firms. One stratagem used by the Malaysian plastics industry is to contract-in foreign expertise to ignite and lead creative developments. However, in most cases, the best foreign talent lack appropriate support and assistance, hence finding the organizational environment non-conducive. Additionally, executing this approach is laden with significant problems since it is very difficult to attract the very best foreign talent, who often are already tied to extremely attractive packages in foreign MNCs or top research laboratories and institutes. Often enough, second or even third tier expatriates are hired due to an inability to hire anyone better. Thus there is a palpable difference in both quality and quantity of advanced skills, and its use in Malaysian plastics industry compared to that of pace setter advanced countries.

MGA analysis shows no difference between large and small Malaysian SMEs along this dimension. Both face similar challenges and approach the problems with the same solution, and therefore encounter similar resultant outcomes.

Knowledge culture has important bearing for innovation, and to be fully effective it must permeate and drive the whole organization. In situations when it not totally pervasive it must prevail in R&D departments and feature strongly in the development of higher order adaptive and especially innovative capability. This is often the case in large firms, where there is higher level of functional compartmentalization due to the sheer size of the organization.

Strong emphasis on sharing and creating knowledge is widely observed in pace setter advanced countries, but the phenomena is much more limited in the Malaysian plastics industry firms. Interestingly, knowledge culture appears not to influence the development of innovative capability. Instead, Malaysian plastic industry firms' directional focus is on absorptive knowledge and adaptive capability. This is in stark contrast to pace setter advanced country firms, where the major impact of knowledge culture is directed towards innovative capability, and is supplemented organization-wide though support initiatives that create foundational level dynamic capabilities.

MGA analysis shows that there is no difference between large and small firms. Where knowledge culture exists it is directed to simply absorbing knowledge created by others, and ingesting it sufficiently to launch their own versions of other innovations.

Organizational capabilities are fundamental in driving firm level outcomes. All three dynamic capabilities work in concert with each other to create innovative outcomes. Outcomes for large and small firms are produced though slightly different pathways in the case of pace-setter country plastic industry firms. Small firms are highly innovative and move very rapidly to commercialize products. Often times they are much faster than larger firms as they are highly focused and agile by nature. However, they are unable to compete with larger firms over the long term because large firms possess a vastly superior resource basin, and have stronger manufacturing capabilities allowing them to reap economies of scale.

MGA analysis shows that Malaysian large and small firms do not show any significant difference from each other. They follow similar pathways. The pattern of outcome effects is, in some sense, similar to that of pace setter country firms although the underlying nature of effects is different. First, innovative capability plays a significant role in driving product-market outcomes as well as process improvement. Adaptive capability is seen to have very strong impact on process improvement. However, the key point of difference is that absorptive capability in Malaysian firms has a negative influence on product-markets. Advanced pace setter firms do not exhibit such an anomalous relationship. This is a telling relationship and is indicative of the different nature of innovation taking place within the Malaysian plastics industry relative to that of pace-setter country firms.

In the Malaysian plastics industry innovation outcomes are constrained by absorptive capability. The reason for the negative relationship is that there is an over-emphasis on absorptive capability, the lowest order dynamic capability. Malaysian firms spend excessive time on learning about others' technology, and even rely on their top talent to understand and copy technologies and knowledge. Too much emphasis on reverse engineering and copying others products, technologies and knowledge limits the firms' commitment of time and investment to synthesizing their own novel advances and creating new knowledge. Over emphasis on copying others knowledge has a tendency to strait-jacket the firm's ability to create products that are disruptive and high-value adding over the long run. Advanced country pace setter firms look at R&D as a long run phenomenon, and invest significantly in areas that they forecast to be good bets for high returns. Malaysian industry takes a short run outlook. Malaysian firms make minimal financial outlay on long run R&D outcomes, preferring instead to copy or make minor modifications of others' knowledge and product offerings.

On a positive note, adaptive capability in the Malaysian plastics industry has a strong impact on process improvement. Unsurprisingly, process improvement features as the main source of impact on economic outcomes. This suggests that Malaysian industry is strongly focused on price competitiveness through incremental process improvement or simple refinement of existing products to meet market needs.

10.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Plastics Industry

Based on the analysis of the knowledge ecosystem of the plastics industry, the key strengths and gaps of the ecosystem are provided in this section of the report.

Key Strengths of the Plastics Ecosystem

- The Malaysian plastics industry is a well-established and competitive industry. The industry has a strong record of good performance.

- The plastics industry is an important component of the manufacturing sector, and provides a significant contribution to employment.

- The plastics industry has strong and active agencies, in the form of a MPMA and MPREC and other supporting institutions working together to develop and strengthen the industry for global competitiveness and innovation advancement.

- Plastics industry features in the supply chains of a diverse range of sectors, and in a number of these sectors they are critical enablers of innovation and competitive performance.

- The plastics industry finds itself at an interesting juncture of development, to navigate the transition from low value to high value positions through a process of strengthening its human and firm competencies base as it transitions to a higher level of automation.

Key Gaps in the Plastics Industry Knowledge Ecosystem

- The plastics industry competes vigorously in a global market place. However, due to weaknesses in strategic fore-sight and their long term outlook, the industry is not able to significantly chart its development in line with industry shaping trends and its current capability set. This is despite the industry possessing strong institutional agents, such as MPMA. The issue is in part due to key institutions working in isolation as well as a lack of strong cooperation among key stakeholders in the industry.

- Lack of a unified vision and understanding between the different stakeholders of the plastics industry. This has often created misunderstanding and mistrust of one another. Ultimately this serves to undermine knowledge sharing as well weaken the co-ordination chain in strategy implementation. Much of the problem stems from weak appreciation of the benefits that can be derived through partnerships with and collaboration between firms, associations, universities, and government agencies. This creates strong disconnects within the supply chain and ecosystem of the industry.

- Networking among the key stakeholders within and external to the industry is weak. Rules of engagement on IP and NDAs are in place but implementation is a problem. The resulting low level of trust creates a highly "protective" approach and low knowledge sharing. The short term outlook of firms at the expense of a long term view of the industry limits the industry's ability to create a collective vision in which collaboration, in select areas, features as much as competition.

- Weak inter-linkages with local universities and research institutions limits the virtuous cycle of knowledge creation, sharing and leverage. Some inter-linkages with foreign research institutions exists but they are ad-hoc and limited due to the high costs involved. Therefore, little knowledge transfer takes place.

- Most firms in the industry, especially SMES, fail to fully understand global trends and market intelligence; especially when considering both the source and level of competition from regional and global players. Many are highly dependent on foreign supply chain players (such as chemical resin manufacturers, plastics machinery manufacturers, (injection moulders, etc.) as suppliers of knowledge for decision-making. There is a pattern of "lock-in" among some firms in the industry, especially micro-SME firms, and this hinders their innovative capacity. To address this, it is necessary to firstly improve awareness of the need for market orientated development and key trends that are likely to shape the global plastics industry. It is also imperative to gradually break away from the heavy reliance and over

dependency on knowledge-feed from suppliers, who by virtue of this fact can create "lock-in".

- Basic technical education in the industry has not kept pace with the changes taking place in the global environment, especially with converging technology platforms, advances in materials sciences and manufacturing systems that are emerging as transformative forces in shaping the global industry structure. There are very few TEVT and technical colleges that prepare graduates for the emerging needs of the plastics industry, such as the operation of advanced manufacturing equipment in automated operations. The curriculum has not kept pace mainly due to poor assessment of core competencies required of all segments of the workforce in the plastics industry. As such, there are significant gaps arising from the plastics industry's over reliance on cheap foreign labour. This is partly a consequence of the inadequate development of a future orientated talent development strategy.

- The industry is unable to attract and retain skilled workers who are able to undertake higher value-adding activities and operations (e.g. Advanced manufacturing skills and new materials and operational knowledge of new standards of practice, embodied in movements such as Industry 4.0 systems) due to poor remuneration packages and non-conducive work environments.

- The above problem is further compounded by the lack of availability of trainers within Malaysia who possess the level of skills needed for basic and advanced industry skills needs. Where it exists, training is expensive and out of the reach of many firms, especially SMEs. This has resulted in a serious shortage of mid-level technical workforce and expertise. Shortage in this segment of the workforce has a major adverse impact on the knowledge ecosystem, which hinders the industry from building a strong adaptive capability. This also prevents firms from translating their dynamic capabilities into process improvement and product development.

- The industry faces a major challenge in attracting high calibre researchers, creative talent and workers with specialized skills sets. The organizational environment of local firms does not sufficiently support innovative endeavour. Even when advanced and technical skills exist they are employed only to adapt products to the existing demands of the market. This leads to serious shortages of staff with sufficient advanced knowledge and skills to reconfigure and apply knowledge for novel and innovative outcomes. The problem is further exacerbated by weaknesses in the ecosystem that hinder strong partnerships and collaborations between research community (universities and GRIs) and industry to undertake translational R&D initiatives.

10.4 Recommendations to Improve the Malaysian Plastics Knowledge Ecosystem

The plastics industry is a key enabling sector that feeds into numerous sectors of the economy. Intense competition arising from China in plastics is eroding the conventional base of competitive strength at the cheaper, price sensitive end of the plastic products. Keeping abreast with the emerging trends at the top end of the market requires significant investment in R&D and upgrade of Malaysian firm competencies. The following recommendations are proposed to strengthen the knowledge ecosystem of the plastics industry.

Recommendation 10.1: Improve Knowledge Context of the Plastics Industry

Malaysian plastics industry players need to plug into current and emerging global plastics issues and programs, such as sustainability, advanced and smart manufacturing (Industrie 4.0 in European terminology), advanced materials science, nano and biotechnologies. This is achieved through a variety of collaborative platforms, involving industry associations, universities and government agencies.

A number of factors need to be considered, including:

- Environmental protection is a key issue driving a range of issues across the supply chain of plastics industry from raw material extraction and synthesis to end-life plastics disposal.

- The institutional agencies of the plastics industry must work closely with each other and in a highly coordinated manner to understand, comply and if possible develop and set in place standards and practices that define the global context of industry practice.

- Emulate practices set by advanced pace setter country plastics industry firms and institutional players in shaping the industry structure and its knowledge context through their actions and response to emerging trends. Plastics industry companies, such as BASF, DuPont as well as other companies in the supply chain not only engage in cutting edge R&D but work hand in hand with institutional bodies to comply with regulations set by bodies such as the OSHA, Environmental Protection Agency (EPA), Food and Drugs Agency (FDA) as well participate in the development of new standards and industry best practices.

Best Practice 10.1: UK - British Plastics Federation, University-Industry Partnerships for Success.

Best Practice 10.5: USA – American Chemistry Council's Plastics Division

Recommendation 10.2: Enhance the Knowledge Institutional System of the Plastics Industry

The Knowledge institutional system of Malaysian plastics industry needs to be strengthened, particularly in terms of co-ordination and execution of programs. In particular, there should be a higher level of coordination and collaboration between trade associations, government agencies, and universities to drive the industry to higher value adding activity. A number of steps can facilitate this:

- Develop a holistic Plastics Ecosystem such that it involves the entire supply chain (upstream-petrochemicals, chemicals; and downstream-auto, electronics, healthcare, etc.) of the industry to ensure continuous support in terms of resources, the sharing of best practices, talents and skills. (see case study Ireland Technology Gateway Programme)

- Strong partnership between industries to ensure nurturance of the ecosystem. This requires strategic alignment of the industries to create space for positive-sum partnerships to flourish.

- Increase coordination and collaboration between trade associations, government agencies, and universities to drive change in the industry. An integrated ecosystem approach is required to encourage and attract greater R&D initiatives, innovation and development of new product and technology within the industry.

- Forge university-industry partnerships for success: Universities need to work closely with the world-class design industry. For instance, in the UK, an extensive amount of path-breaking innovations take place through this process: for example, in plastic blood (at the University of Sheffield).

Best Practice 10.1: UK- British Plastics Federation, University-Industry Partnerships for Success.

Recommendation 10.3: Develop the Knowledge Capital of the Plastics Industry

Comprehensive talent and skills management strategy needs to be formulated to fill gaps in current skills. Future skill industry needs must be mapped out and actions defined to develop quality and quantity of skills for long term success. A number of steps can be taken towards this:

- Revise vocational education to encourage specialised skills and knowledge for the future workforce in the plastics industry.

- Affordable training programs to continuously upgrade the skillset of the workforce should be in place – these programs should be jointly conducted with key colleges/universities in partnerships with industry, as part of initiatives, such as the Manufacturing Extension Program.

- Provide industrial training, apprenticeship and internship opportunities with leading firms both globally and locally to ensure that individuals are "work-ready."

- Foster strong university-industry collaboration in curriculum design, course development, internships and work placements.

Best Practice 10.4: EU Modernization of Vocational Education and Training

Best Practice 10.9: SPI- the Plastics Industry Trade Association

Recommendation 10.4: Develop the Knowledge Competency of the Plastics Industry

A number of initiatives can be taken to develop the knowledge competency of the Plastic Industry. These include:

- Identify specific universities to focus on industry specific research needs as well as undertake both fundamental and translational research in the plastic industry. Selected universities should work in conjunction with institutions, such as the Plastics & Rubber Institute Malaysia (PRIM) and Tun Abdul Razak Research Centre to ensure knowledge development is aligned with future needs of industry.

- There is also a need to nurture talent and competencies in specialist areas needed by specific sub-sectors of the industry to capitalize on emerging trends: Biotech, Nanotechnology and Material Sciences. It is necessary to identify focus their areas of priority so that a directed effort can be made to develop key competencies areas. Thailand's focused development of the bio-plastics industry niche is an example of a strongly focused and coordinated effort in competency building from a weak starting position.

- Increase scholarship programmes in specialized areas required by the industry to meet future skills, knowledge and talent needs. The spread of scholarships should ensure the right distribution of breadth and depth of skills is available for industry; from technical and vocational skills to post-doctoral researchers with advanced specialisations.

Best Practice 10.3: Thailand – Developing the Bio-plastics Industry Niche

Best Practice 10.6: Plastics Institute of America

Recommendation 10.5: Facilitate Knowledge Learning & Transfer within the Plastics Industry

Establish a strong industry network with a shared collective vision of overall development so as to enable the set-up of shared facility or centres to support firms in particular areas, especially specialized needs within the supply chain. The sharing of resources can help create positive spill-overs in cross-cutting capabilities that firms can use to benefit each other in a mutually symbiotic manner. In addition to this, the following activities are needed:

- Encourage the creation of partnerships between industry, universities and CoE's such that new knowledge can be built and shared. Also, encourage firms to engage in partnership in order to access complementary skills and competencies.

- Increase fiscal (R&D grants, subsidies and tax exemptions) and non-fiscal (access to R&D and testing facilities) incentives to facilitate growth, based on capability.

- Foster continuous learning opportunities for SMEs through affordable training programs and courses via universities, colleges, polytechnics, training institutes etc.

- Increase trans-sectoral and transnational mobility to promote international and inter-sectoral acknowledgement of certificates and training courses, including work mobility programmes to encourage skills development.

Best Practice 10.7: Australian Government- Department of Industry, Innovation and Science

Recommendation 10.6: Incorporate an Innovative Knowledge Approach within the Plastics Industry

Tackle the fragmented structure of the Malaysian plastic industry by supporting consolidation through the appropriate M&A measures, so that the players who remain and grow in size are able to build the correct competencies as well as realize economies of scale necessary for automated advanced operations. Doing so will help firms seize advantage of larger market opportunities arising from the recent opening up of ASEAN markets. Where consolidation is not possible, it is necessary to ensure that firms that do not possess sufficient resources and R&D capabilities are able to tap into technological infrastructure and scientific expertise for them to at least trial and experiment with their innovation ideas. Following the sufficient development of innovation ideas, they can look to alternate options of funding and commercialization. In addition, the following actions will improve the propensity of firms to innovate.

- Identify local innovative companies that are able to take up leadership positions through the development of patents and products in specific niche area(s. They should be provided access to R&D funding, technological infrastructure, expertise, networks and other support systems to extend their market share in the region and globally. This will help establish them as leaders as well as influence local firms to emulate their success.

- Put in place policies to encourage foreign and local firms to use locally manufactured plastic materials. This will provide a much needed boost to the industry and the local economy.

Best Practice 10.8: (Australian Government, DIIS, Science and Research Priorities)

Recommendation 10.7: Strengthen the Knowledge Leverage within the Plastics Industry

Establish strong research interaction between CoEs, GRIs, universities and industry. Interactions, if they are premised on win-win partnerships through sharing of complementary resources, will lead to higher levels of process improvement and product development. Strong benefits can be realised through infrastructure sharing and technology/knowledge transfer; such as an increase in the number of intellectual properties (IPs) and patents; improved commercialisation of IPs/patents; and, creation of new revenue streams. A number of initiatives can be implemented within the plastics industry to facilitate better knowledge leverage, such as the following:

- Key research institutes (universities, GRIs and CoEs) can be important 'One-Stop Centres' for firms in the industry. The online portal can also be an important source of information for services such as access to financing, expertise, research infrastructure, new science & technology and discoveries related to the palm oil industry.

- The various universities, colleges, polytechnics and training institutes can be knowledge centres in the various localities providing advice on business development, new innovations and technology, market opportunities, networking and other resources that enhance knowledge content and business development.

- Align the KPIs and financial support for local educational institutions to serve the firms and local communities in the plastics industry to build knowledge content and enhance their innovative capacity. To incentivise these institutions to be key enablers for knowledge dissemination and leverage for firms, financial support should be aligned to services provided to the local firms in terms of building knowledge content and move up the innovation value chain.

Best Practice 10.2: Ireland – Applied Polymer Technology, Ireland Technology Gateway Programme

10.5 Conclusion

This chapter examined the state of the knowledge ecosystem for the Malaysian plastics industry. The analysis highlighted some of the key strengths and gaps in the knowledge ecosystem. In particular, the study identified the key knowledge enablers that are strong and have enabled the industry to be a major player in the global plastic market. The empirical analysis also identified some of the weaker links in the ecosystem and key reasons for these gaps in the ecosystem. In this chapter, we also discussed key policies and strategies to strengthen the knowledge enablers so as to ensure that the dynamic capability components of the industry is strengthened.

Appendix for Chapter 10

Best Practice 10.1: UK- British Plastics Federation, University-Industry Partnerships for Success.

- Longest established Trade Federation in the world- represents 75% of industry with 400 direct members and 1600 affiliates, and 140,000+ employees, covers materials, machinery and processors.

- The Federation is leading the way in understanding what sustainability means for industrial materials and continues to make strong investments in the plastics industry, especially to support frontier R&D activities in bio-based plastics, natural bio-based polymers and synthetic bio-based polymers.

- Industry is served by several excellent centres of excellence in Belfast, Bradford, Queens, Loughborough, London Metropolitan, and Napier, Edinburgh that lead innovation for the industry.

- Many of the industry work closely with the world-class UK design industry. Examples of leading-edge innovations include: Plastic Blood (University of Sheffield), Innovative dissolving textiles (University of Ulster and Sheffield Polymer Centre), Gloves enabling wearers to climb walls (with the University of California).

- The plastics industry is the backbone for the aircraft industry such as A380 (22% carbon fibre) and Boeing 787 (40% plastic composite fuselage), which results in savings in fuel and ultimately is better for environment.

http://www.bpf.co.uk/

Best Practice 10.2: Ireland – Applied Polymer Technology, Ireland Technology Gateway Programme

Ireland Technology Gateway network provides Irish companies near to market solutions in a wide range of areas; one of the areas is in applied polymer technology. Innovations in applied polymer technology provide solutions for a wide range of industries such as medicine, recycling, pharmaceuticals, automotive, packaging, construction and composite materials. Among the support provided by this network includes the following:

- Offers firms, both local and nationally, access to world class R&D infrastructure, expertise and resources.

- Provides firms access to technological expertise to generate solutions for the market needs of the industry.

- Helps establish partnerships between research institutes and firms to facilitate technology transfer, and encourages applied research and the development of technical expertise.

- Works closely with Plastics Ireland to help industry gain access to raw materials, services, equipment and processors for firms in Ireland.

- Link with key institutions that provide facilities for incubation for knowledge intensive firms and start-ups.

- Works closely with the industry to ensure that the skills training program administered meet the needs of the industry, including facilitation of certification and development activities.

https://www.enterprise-ireland.com/en/research-innovation/companies/collaborate-with-companies-research-institutes/technology-gateway-programme.html

Best Practice 10.3: Thailand – Developing the Bio-plastics Industry Niche

- The country set an aspiration to be the global hub for bio-plastics industry. Thereafter, institutions worked together to play an active and coordinated role in promoting and advocating for bio-plastics initiatives.

- Established key agencies, fostering key collaborations and partnerships between institutions, associations, universities and industry wide network to develop the industry.

- Reduced cost of raw materials: firms are offered tax incentives for R&D, and reduced import duties for materials not available in Thailand are in place as part of their initiatives to enhance the development of the plastic industry.

- Promoted and supported development and launch of local bio-plastics products to attract local consumers as the first step in establishing competitive advantage.

- Focused on accelerating technology development through creating a cooperative blend of adopted international technologies with domestic innovation.

http://www.nia.or.th/bioplastics/

Best Practice 10.4: European Union – Modernisation of Vocational Education and Training (VET)

- Revised its general and vocational education to encourage specialised skills and knowledge for the future workforce in rubber and plastics industry.

- Training and lifelong learning is in place for firms in the industry, and this is widely beneficial to SMEs.

- Supports and upgrades the industry by providing benchmarks and best practise solutions that are open and accessible to education and training providers as well as firms.

- Provides information on current and future skills and knowledge needs as well as job requirements. This is essential for effective training and educational provision.

- Enhances trans-sectoral and transnational mobility to promote international and inter-sectoral acknowledgement of certificates and training courses, including work mobility programmes to encourage skills development.

- Provides higher focus and attention to interdisciplinary and multidisciplinary skills and knowledge.

Best Practice 10.5: USA – American Chemistry Council's Plastics Division

- American Chemistry Council's Plastics Division represents leading companies and is dedicated to providing innovative solutions to tomorrow's challenges through plastics.

- It is a major promoter of local products to industries in the country and across the globe – i.e, a strong advocate to persuade government, consumers and industry to use local products first.

- Working closely with America's plastics makers, it has played a role in setting standards to improve human lives both in US and globally. For example, it was at the forefront for developing bicycle helmets, child safety seats, airbags, cell phones, microwave safe plastics and other products that use plastic resin. It was also at the forefront for developing standards for helmets, airbags and food safety and promoting environmental friendly practices. The division also helped reduce greenhouse emissions and waste by leading "REDUCE, REUSE, RECYCLE AND RECOVER" campaigns through outreach and education as well as providing access to recycling technology.

https://www.americanchemistry.com/ProductsTechnology/Product-Specific-Groups/

Best Practice 10.6: Plastics Institute of America

- The Plastics Institute of America's primary objective is to help advance the growth and progress of the plastics industry through education and research.

- The PIA offers a diverse array of resources tailored for all segments of the plastics industry -- from in-plant (on or off-site) training for workers on the shop floor to industry-specific short courses and seminars for executives.

- On and off-site offerings are tailored to enhance the skill levels of: machine operators, plant mechanics, electronic technicians, and other manufacturing support personnel.

- Executive courses concentrate on administrative issues, including new technologies, concurrent engineering, work organization, and legal issues.

- The PIA also serves and responds to a variety of industry needs not addressed by other organizations. These initiatives include:
  - ❏ Serving as an informal resource and "hot line" providing knowledge and advice on plastics materials and processing, research funding, grants, consultants and specialized services.
  - ❏ Identifies researchers and puts them in contact with industry professionals who are in need of research in specific areas.

- PIA is supported by all facets of the industry. Its members represent suppliers of materials and additives, equipment manufacturers, large and small producers and consumers of plastics products, converters, trade publications, educators, and government officials.

- Major organizations support the Institute. Many have representation on its board of directors, and include: the Society of the Plastics Industry (SPI), the Society of Plastics Engineers (SPE), the Society of Manufacturing Engineers (SME), the Plastics Pioneers Association, the National Plastics Center & Museum (NPCM), the American Plastics Council (APC), leading industry magazine/publishers and editors, the U.S. Government, consultants and representatives at top levels from leading plastics companies worldwide.

http://www.plasticsinstitute.org/about.php

Best Practice 10.7: Australian Government-Department of Industry, Innovation and Science

Department of Industry, Innovation and Science (DIIS) recognizes a competitive Australian chemicals and plastics manufacturing industry and plays an important role in the success of the Australian economy. The sectors' products support other vital industries like food, automotive, building and construction, packaging, medical, agriculture and mineral processing industries. The chemicals and plastics manufacturing industry value adds in the order of $11.4 billion and provides over 50,000 jobs.

Department of Industry, Innovation and Science (DIIS) as part of its remit aims to facilitate increased productivity, sustainability, competitiveness and growth of the Australian chemicals and plastics industry by fostering an environment that allows businesses to innovate and capitalise on global opportunities.

The department assists other Australian Government agencies to ensure the interests of the sector are taken into account during policy development and liaises with industry stakeholders on new or changing policies.

It also produces a data card on the status of the chemicals and plastics manufacturing sector which is updated regularly.

http://www.industry.gov.au/industry/IndustrySectors/Pages/default.aspx

Best Practice 10.8: Australian Government- DIIS- Australia Government: Science and Research Priorities

The Australian Government has developed a set of Science and Research Priorities, and corresponding Practical Research Challenges, designed to increase investment in areas of immediate and critical importance to Australia and its place in the world.

The Australia Government recognizes that, like other countries, its capacity to support research is finite. With diverse investments in research across multiple agencies and many processes, it needs to ensure that it builds its capacity in research areas of particular importance to the nation.

The Government's ***Industry Innovation and Competitiveness Agenda*** states that Australia's research priorities align with its comparative advantages. The Government's ***boosting the commercial returns from research*** paper calls for national science and research priorities to be linked to corresponding practical challenges. Led by the former Chief Scientist, Professor Ian Chubb AC, the Priorities and associated Practical Challenges were developed in consultation with researchers, industry leaders and government representatives. The Science and Research Priorities and associated Practical Challenges ensure that appropriate levels of public funding are allocated to research that address the most immediate problems facing the nation.

The implementation of priorities is expected, over time, to result in an increased proportion of Australian Government research investment allocated on a strategic basis to areas of critical need and national importance.

- Explicit acknowledgement addressing the Priorities and Practical Research Challenges that require effort from across the full spectrum of research disciplines, including the physical and life sciences, engineering, information and communications technology and the humanities and social sciences. This requires a coordinated approach from all Government departments and agencies.
- Cross-cutting issues related to the priorities present challenges in their own right and are addressed through a whole-of-government strategic approach. These include big data, research infrastructure, workforce and international collaboration.
- The Science and Research Priorities and Practical Research Challenges are reviewed every two years to allow for new initiatives to take effect and to ensure that issues being addressed are still the most pressing for the nation.

http://www.science.gov.au/scienceGov/ScienceAndResearchPriorities/Pages/default.aspx

Best Practice 10.9: SPI- the Plastics Industry Trade Association

SPI: The Plastics Industry Trade Association actively promotes the growth of the annual $427 billion US plastics industry. The industry accounts for nearly one million American workers, making it the third largest US manufacturing industry.

SPI represents the entire plastics industry in a way that promotes the development of the plastics industry and enhances the public's understanding of its contributions while meeting the needs of society and providing value to its members. SPI accomplishes its objectives through a variety of programs, including:

- representing the industry before federal and state government bodies,
- informing members about important legislative and regulatory policy developments,
- identifying trends and emerging issues of concern,
- building coalitions to help achieve industry goals, and
- communicating the value of the plastics industry and its products to key audiences.

SPI also serves as a resource for members needing technical expertise, statistical information and regulatory compliance assistance.

It liaises with national and international technical and regulatory groups to develop standards for product performance and safety to protect existing markets for plastics and open new ones.

Through its national, international and regional activities, SPI promotes industry growth and development through a variety of programs to improve company performance and create a positive business environment for the plastics industry.

SPI also sponsors NPE, the international plastics showcase for the industry and its products and an unparalleled forum for industry interaction.

In addition to SPI's core services, SPI's industry groups and program committees serve the special needs of various industry segments. Some units are formed around specific materials, manufacturing processes and end markets, while others represent plastics machinery and equipment manufacturers or product manufacturers.

SPI Governance is comprised of five leadership councils: equipment, material suppliers, bio-plastics, processors and brand owners along with special purpose groups and committees that tailor services for their specific community of members.

SPI's industry councils (Equipment, Material Suppliers, Processors and Brand Owners) represent the foundation of the organization, and they have a direct pipeline to both the Executive Board as well as to SPI's tactical committees to ensure that the needs of today's industry are being addressed. These councils are able to flexibly set budgets according to the ebb and flow of a rapidly changing marketplace. All member company representatives have a voice within SPI's Council structure. Council programs and initiatives are accessible to members throughout the supply chain.

http://www.plasticsindustry.org/

References

1. The European House of Ambrosetti, 2013 The Excellence of the Plastics Supply Chain in Relaunching Manufacturing in Italy and Europe. Retrieved from www.plasticseurope.org/cust/documentrequest.aspx?DocID=60702

CHAPTER 11

KNOWLEDGE CONTENT OF THE MALAYSIAN CHEMICAL INDUSTRY

CHAPTER 11
Knowledge Content of the Malaysian Chemical Industry

11.0 Introduction

The chemicals industry is an important contributor to the overall economic industrial development in Malaysia. There is hardly any industry where chemical substances are not used; this includes agriculture, automotive, electrical and electronics, pharmaceuticals, construction and petroleum. Technological innovation in the chemicals industry leads to positive spill-over effects on other industries.

The chemicals industry is one of the leading and most developed industries in Malaysia. It is the second largest contributor to the country's total exports of manufactured goods (MATRADE, 2016a). The chemicals industry consists of various sub-industries, including oleochemicals, petrochemicals, and agriculture chemicals. The Malaysian chemicals industry is particularly advanced in petrochemicals and oleochemicals due to the abundance of raw materials (palm oil and natural gas/petroleum). The strength is evident through continuous growth rate of exports in both petrochemicals and oleochemicals (see **Table 11.1**).

Table 11.1: Continuous Growth in Chemicals Exports in 2015

Description	2014		2015			
	Million (RM)	Share %	Million (RM)	Share %	Change (value)	Change %
Total exports of chemicals	51,446.90	100.00	55,142.40	100.00	3,695.50	7.20
Petrochemicals	22,153.40	43.10	23,393.30	42.40	1,239.90	5.6-
Oleochemicals	12,094.10	23.50	12,278.60	22.30	184.40	1.50

Source: MATRADE (2016a)

11.0.1 Oleochemicals

Malaysia is a dominant player in the global oleochemical industry, being the world's second-largest producer and exporter of palm oil and palm oil-based products (ETP Annual Report 2014). The country is also commensurately strong in oil palm research.

11.0.2 Petrochemicals

The steady growth and development in the petrochemicals industry is driven by a concerted national effort to turn Malaysia into a hub for the petrochemicals industry and for the ASEAN market. The wide range of petrochemicals produced in Malaysia contribute significantly to the development of the local downstream plastic industry, making it one of the most dynamic industries in the country's manufacturing industry.

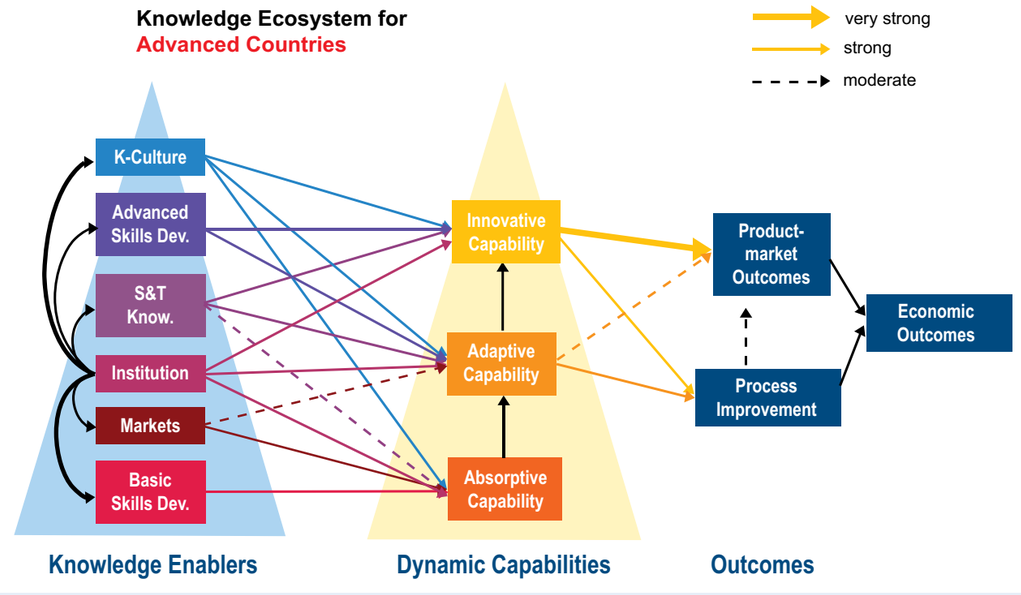
11.0.3 Agrochemicals

The market for agrochemicals industry is highly consolidated and controlled by dominant multinational players that account for 75% of total market share (e.g., Bayer, Du Pont, Dow, Monsanto) (Persistence Market Research, 2014). Given the considerable growth in demand in Southeast Asia's agriculture industry, there is a large avenue for potential growth through the agrochemicals market. However, market consolidation by top multinational chemical companies makes it very hard for local business to penetrate the market. Another limitation for local players is that the domestic market for chemicals remains relatively small.

11.1 Knowledge Ecosystem for the Chemicals Industry in an Advanced Country

The knowledge ecosystem of the advanced country chemicals industry capturing the intricate relationships between knowledge enablers, dynamic capabilities and economic outcomes is shown in Figure 11.1. The figure shows the industry in advanced economies to be defined by the richness of interlinks between knowledge enablers, dynamic capabilities and outcomes. Knowledge enablers of the chemicals industry ecosystem are strong and play a significant role in the nurturance and development

Figure 11.1: Complex Relationships in the Chemicals Industry in an Advanced Country



of strength in dynamic capabilities. Firms in the chemicals industry of advanced countries possess relatively strong capabilities which they leverage to create high level process improvements and new product developments. Ultimately the effects of these combine to contribute to economic outcomes.

The knowledge ecosystem for the chemicals industry in an advanced country is characterized by a significant level of maturity and the industry plays a major role in the wellbeing of the national economy. To ensure that chemical industry companies are robust and globally competitive, considerable resources are invested in skills and competencies development and R&D through a broad array of programs. Knowledge enabler activities play a significant role in developing the capability of firms They feature significantly in developing strength in absorptive, adaptive and innovative capabilities, and help firms produce innovation outcomes. Advanced country chemicals industries are characterized by the following:

- Aligned Policies and Strategies with Global Industry Trends, Standards and Best Practices (Knowledge Context) – Major global trends, such as nano-materials, biotechnology, smart products such as biogradeables and eco-efficient advanced process manufacturing systems define the standards and best practices of firms operating in the industry.

- Knowledge Institutional System of the chemical industry – Institutional players, government bodies, industry associations and universities come together as partners to develop visions and plans for the industry. They identify key priority areas of development and develop clear implementation strategies and KPIs. Multi--stakeholder buy-in is an essential underlying characteristic of seamless execution of policy and plans.

- Knowledge Capital of the Chemicals Industry – A key concern is the adequate supply of human skills to deal with future needs of the chemical industry as emerging trends start to make demands for new forms of skills and competencies. Proactive provisions are made to ensure the chemicals industry is well prepared to cover any areas of skill deficiency necessary for future competitive success.

- Knowledge Approach within the Chemicals Industry – Firms in the chemical sectors are strongly encouraged to innovate and align to emerging trends. Firms are incentivized to invest in R&D and use advanced technology to proactively create high value added products for the future. Many firms proactively adopt a highly entrepreneurial approach and set out to generate new revenue streams from innovation.

- Knowledge Competency for the Chemicals Industry – A deep and specific understanding of the future challenges in all key aspects of chemicals, from feedstock to processing is articulated and mapped out. Systematic programs are set into motion to ensure readiness to deal with emerging challenges and competitive pressures.

- Knowledge Learning & Transfer within the Chemicals Industry – Knowledge and innovation networks are formalized to bring together businesses, entrepreneurs, academics and funding agencies to ensure knowledge is shared. Well integrated frameworks are in place to develop priority areas to create the necessary flows of S&T and R&D, and knowledge is connected to ensure spill-over benefits are fully reaped by industry.

- Knowledge Ecosystem of the Chemicals Industry has architecture in place to ensure optimal Knowledge Leverage. Institutions (government agencies, industry association and educational institutions) play a key role in establishing platforms and forums of exchange of information and transfer of knowledge to firms in the industry. Specific platforms and infrastructural facilities are created to ensure that all players in the industry, especially entrepreneurial SMEs, are able to access advances in technology, R&D and other knowledge to improve their operations and develop high value-added new products and services.

Example of best practices of the above are given in appendix.

11.2 Knowledge Ecosystem of the Malaysian Chemicals Industry

In this section, we provide a brief description of the knowledge ecosystem for the Malaysian chemicals industry based on survey data. Survey participants comprise of 48 large firms and 83 SMEs, giving a total of 131 firms. Of these, 51 are foreign firms and 80 are local firms. Figure 11.2 shows the state of development of knowledge enablers. Most enablers exhibit moderate performance. Notable weaknesses appear in institutions, market and S&T components of knowledge.

Figure 11.3 shows the dynamic capability components, process improvement and product development in the Malaysian chemicals industry vis-à-vis the position of an advanced country. The dynamic capability components, process improvement and product development were measured for large, SMEs, local and foreign firms. The dynamic capability, process improvement and product development for advanced countries are measured to be significantly higher than those of the Malaysian chemicals industry. Foreign firms established in Malaysia are observed to have around the same levels of dynamic capability as large local firms. SMEs are slightly weaker across most dimensions.

Figure 11.2: Knowledge Enablers for the Malaysian Chemicals Industry

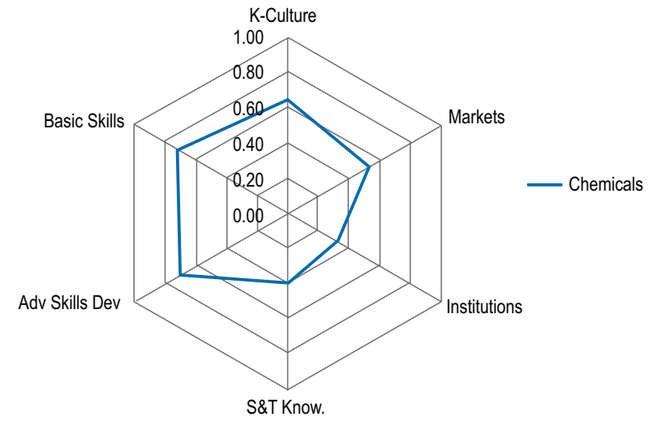
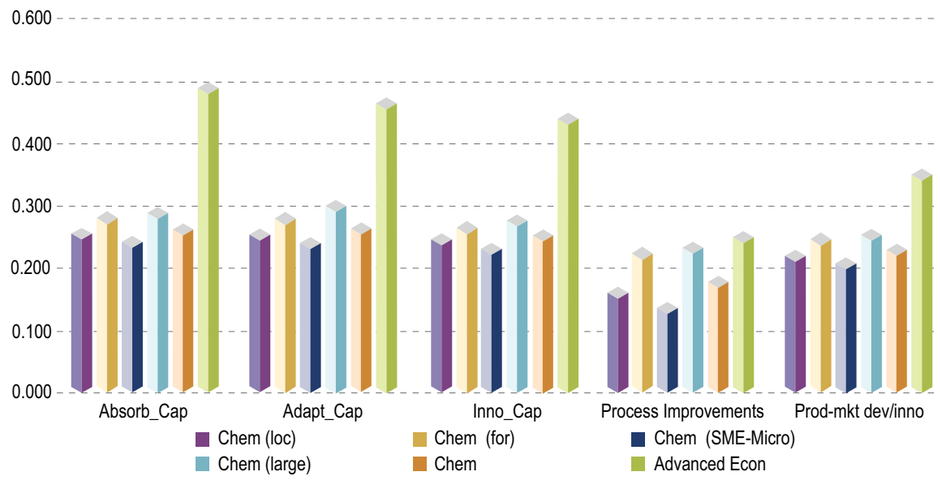


Figure 11.3: State of the Dynamic Capabilities of the Malaysian Chemicals Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

Figure 11.4: Strategic Posture of the Firms in the Malaysian Chemicals Industry

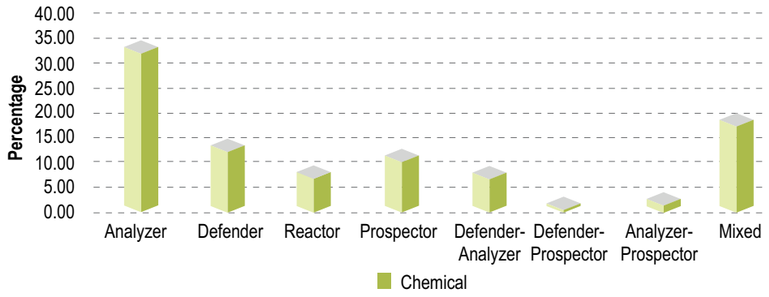
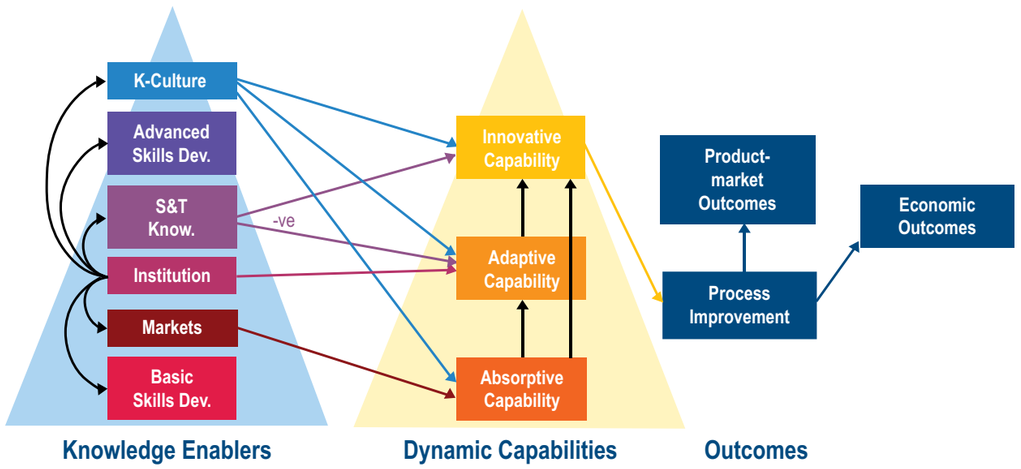


Figure 11.5: Knowledge Ecosystem of the Chemicals Industry



The strategic posture of firms in the Malaysian chemicals industry is given in Figure 11.4. The figure shows that a majority of firms are Analyser firms, followed by Prospectors. Prospector firms weigh in at just above 10%; the proportion is higher than Defender and Reactor firms and is a positive indicator that a good number of firms in the sector are transitioning towards innovation led strategies.

The knowledge ecosystem for the chemicals industry is shown in Figure 11.5. Malaysia's chemicals knowledge ecosystem is comparatively weak compared to ones observed in more advanced countries. The following key characteristics can be observed for the Malaysian knowledge ecosystem:

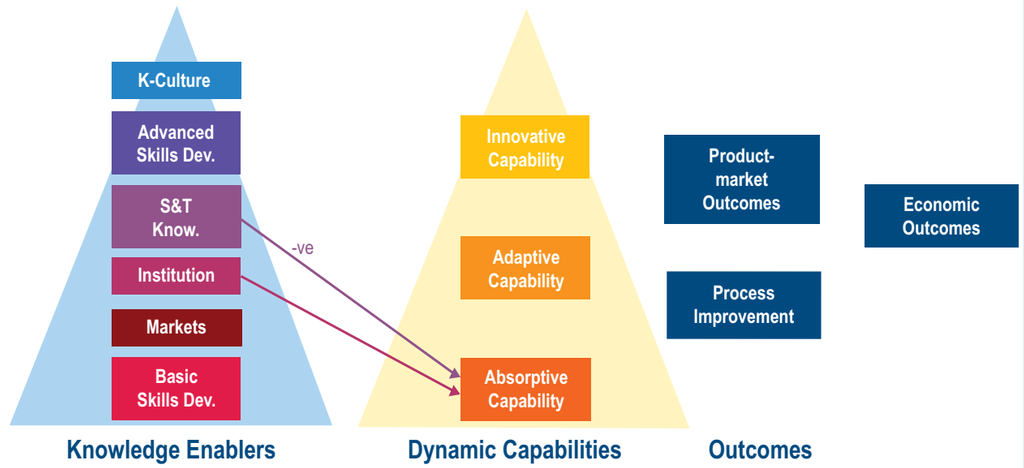
- Basic skills do not influence organizational DC capability building.
- Markets drive absorptive capability building; this is a positive indication of firm level market responsiveness, even though other enablers do not feature in absorptive capability building.
- Institutions play a positive and significant direct role in enhancing adaptive dynamic capability building. In influencing other capabilities, institutions are observed only to indirectly affect dynamic capabilities through strengthening of other knowledge enablers.
- S&T knowledge appears to hamper adaptive capability whilst enhancing innovative capability. This suggests S&T utilization at the mid-level is deficient in that firms may not have the necessary skills at the middle strata of the organization or the focus is misaligned and fails to be sufficiently connected and assimilated into the manufacturing or marketing processes.
- Advanced skills do not feature significantly in the development of any of the organizational capabilities. This could be due to the industry's focus on commodity type products rather than high fundamental scientific endeavour in chemicals development. An absence of direct positive effects from advanced skills in the development of dynamic capability is likely to be due to either lack of sufficiency of advanced skills to create break-through advances or due a shortage of technically competent staff at the middle-level and R&D operations in the industry. The shortage of technically competent staff hinders the chemical industry firms from making any significant refinements and improvements to existing knowledge. Hence, firms are unable improve the quality of their production processes or develop significant new products.
- Knowledge culture positively nurtures development of all DCs. However, only innovative capability yields significant effects on process improvement. Process improvements enhance product-market innovation, and feature as the basis for creating economic outcomes. Emphasis on process improvement suggests that the primary mechanism used by firm in the industry for market success is price based competition.

The evidence suggests a knowledge ecosystem that is unable to substantially develop the Malaysian chemicals industry to a higher platform even though positive signs of transition to higher value added activity exist. The Malaysian chemicals industry manages to create some level of innovation, but the primary path to doing so is through process improvement and price competition to drive market penetration.

The chemical industry ecosystem was compared for large and micro-SME firms and the results of the multi-group analysis are presented in Figure 11.6. The key observation to emerge from the analysis are as follows:

- Large chemical firms appear to be more adept at utilizing institutional support and facilities to absorb and internalize knowledge.
- Small firms, on the other hand, revert to using S&T for absorptive capability development. In other aspects, small and large firms follow similar patterns.

Figure 11.6: Knowledge Ecosystem for Chemicals Industry Large versus Micro-SME



- The Analyzer approach is the most common for both large and small firms. There is a higher proportion of SME Analyzer firms than large businesses. More large firms are Prospectors. This indicates a stronger propensity toward innovative activity within large firms compared to small firms.

Comparative assessment of local firms against foreign firms suggests:

- Foreign firms possess slightly higher level DCs than local firms though the gap is marginal, especially in terms of absorptive and innovative capability. However, despite near-parity in the level of DC possession, foreign firms yield higher innovation outcomes.

- Surprisingly, foreign firms appear to tap into institutional support mechanisms more effectively than local firms, and they are more effective in tapping into the knowledge culture to develop adaptive capability.

- Local firms show a stronger tendency in making attempts to develop innovations directly from market insights, rather than utilize the more systematic hierarchical DC capability building approach of foreign firms. Such quick approaches typically take place when firms are trying to catch-up on other innovations. However, without sufficient strength in foundations, many of the attempts to catch-up end up in failure.

11.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Chemicals Industry

Based on the analysis of the knowledge ecosystem of the chemicals industry, the key strengths and gaps of the ecosystem are briefly covered in this section.

Key Strengths of the Chemicals Ecosystem

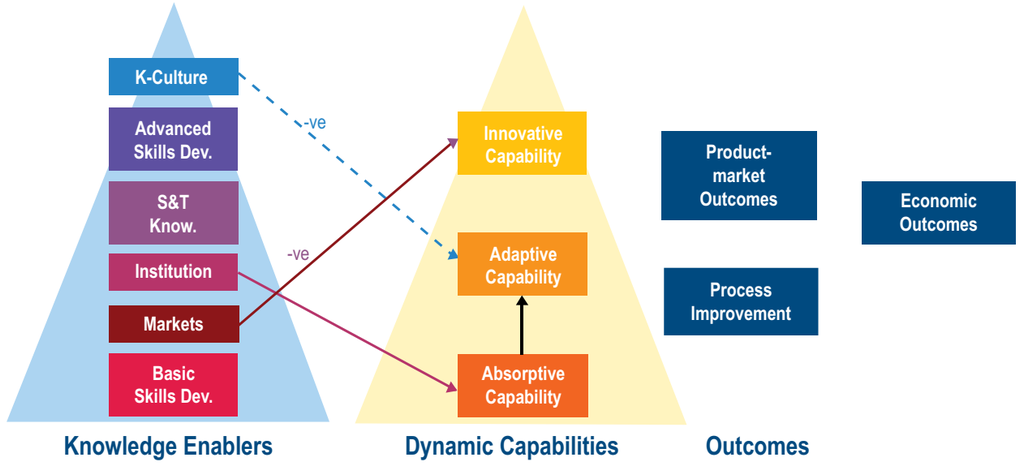
- Malaysia is blessed with a wealth of natural resources which feed into the chemicals industry. This gives Malaysia an advantage over other countries that are resource constrained.

- The chemicals industry has received significant support from the Malaysian government over the years and is one of the leading sectors and revenue generator for the country.

- The chemicals industry is a strong enabler of other sectors, and has very strong interlinks with almost every other sector of the economy, including plastics, electronics, agriculture, construction and pharmaceuticals.

- The chemicals sectors are capital intensive and hi-tech in nature, requiring highly trained R&D personnel as well skilled operators for complex manufacturing processes. This provides significant opportunity to develop high capability and engage in high value added activity.

Figure 11.6: Knowledge Ecosystem for Chemicals Industry Foreign versus Local



- The Malaysian business environment is widely conducive and strongly facilitates FDI inflow, leading to a significant number of MNCs setting up within Malaysia.

- The sector is driven by innovation, and provides considerable opportunity for Malaysian companies to take advantage of opportunities if they are able to develop required competencies and firm capabilities.

Key Gaps Knowledge Ecosystem

- The chemicals industry is a heterogeneous industry with a diverse skill-set requirement, which are poorly understood by institutions. As a result, there is a lack of coherence in the execution of training and development programmes by local government agencies, colleges and universities. This hinders progress in human capital development and leads to significant skills gaps. Strategic approach to training and development is required in order to develop career pathways for upgrading individuals and ensure they have the skills for the future needs of the industry, especially as it transitions to a high value added industry.

- Although significant effort has been made in the right direction and the chemicals industry is a leading industry for Malaysia, there still remains shortage of staff with sufficient advanced knowledge and skills to reconfigure and apply knowledge for novel and innovative outcomes. For a sector that is heavily reliant on R&D as the basis of value add, the local firm's organizational environments do not sufficiently support innovative endeavour. Even when advanced and technical skills exist they are employed only to adapt products to existing demands of the market.

- Additionally, talented individuals are not given space to work collaboratively with leading university researchers to make novel advances. This prevents individuals in developing their skills while at the same time contributing to the firms' innovation agenda.

- Adding to the above, there is insufficient collaboration between companies and research universities. A lack of leading research institutions contributes to the problem. Talented locals find it difficult to develop and stretch their skills, and many end up leaving the country for better opportunities elsewhere.

- SMEs' awareness and responsiveness to market shifts is weak. Many of the SMEs are reliant on foreign MNCs to provide them with knowledge on chemicals resins; often they end up being locked into the supply chain of MNCs. Unfortunately, local players appear not to be able to create significant knowledge transfer from their engagement with MNCs to drive innovation trajectories of their own. Adding to this is reliance on importing/buying machinery, technologies and raw materials from foreign countries. This makes the industry highly reliant and locked into the technological trajectories of others. Under such conditions it is difficult for local firms to innovate unless they are able to build a sufficient depth of knowledge locally.

- Local firms, especially SMEs, take a cautious approach to the market, with a strong focus on maximizing short run profits at the expense of long term gain. This outlook hinders them from exploring significant niche areas and invest in R&D where they could create pathways for growth.

- Foreign consumer groups, notably those in Europe, are beginning to oppose commodities and chemicals derived thereof on the grounds of sustainability. This may impact the attractiveness of chemical commodities originating from Malaysia.

- Numerous attempts have been made by regulators and industry agencies to create enabling environments. However, despite good intentions, these initiatives have failed to jumpstart Malaysia's transformation toward becoming an advanced global player in the chemicals sector.

The local institutional and regulatory environment also makes it difficult for firms to take long term risks in penetrating international markets with novel products and services. This is because agencies tend to work in isolation, addressing market gaps in a fragmented manner. This weakens the process of building the dynamic capability components of firms.

11.4 Recommendations to Improve the Malaysian Chemicals Industry Knowledge Ecosystem

The chemicals industry is a key contributor to the Malaysian economy. The chemicals industry globally is undergoing intense competitive pressures. Excess capacity is a feature of the industry and has led to a range of industry impacts: chemicals commoditization has driven strong consolidation to realize economies of scale, primarily through merger and acquisitions; company portfolios have received scrutiny for better risk-return balance given that chasing specific molecular trajectories into the different stages of the value chain through innovation has been exhausted over time; specialty chemicals areas are also maturing, and require fresh innovation streams; and price pressures are becoming intense with the appearance of strong new players from emerging nations, such as China, India. The slow growth environment coupled with shifting market dynamics make a challenging environment for chemicals companies. To ensure the strength and viability of the industry, the following recommendations are proposed to strengthen the knowledge ecosystem of Malaysia's chemical industry.

Recommendation 11.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Chemicals Industry

The global chemicals industry is governed by the global charter on Responsible Care Conduct, which entails the following: ensuring the sustainable development of the chemicals industry; continual improvement and performance reporting; enhancing the management of chemical products worldwide; championing and facilitating the extension of Responsible Care along the chemicals industry's supply chain; actively supporting national and local Responsible Care governance; addressing stakeholder expectations about chemicals industry activities and products; and providing appropriate resources to effectively implement Responsible Care.

To penetrate the global markets, local industry must meet these global standards and best practices. This will require the Malaysian industry to invest in talent, infrastructure, technology, governance systems, monitoring, surveillance and other support systems. Achieving this will require a number of actions, as follows:

- Establish a high-level panel consisting of key stakeholders to develop a strategic master plan for the chemicals industry with clear KPIs, resources and outcomes to raise innovative capacity and competitiveness in priority areas.

- Development of a holistic Chemicals Ecosystem such that it involves the entire supply chain (upstream and downstream) of the industry to ensure continuous support in terms of resources, sharing of best practises, talents and skills.

- Integrated ecosystem approach to encourage and attract greater R&D initiatives, innovation and development of new product and technology within the industry.

- Strong partnership between industries across the supply chain to ensure nurturance of the ecosystem. This requires strategic alignment of upstream and downstream industries to allow win-win partnerships to flourish.

Best Practice 11.1: PACIA

Best Practice 11.9: Australian Council of Learned Academies (ACOLA) - Understanding Progress: Broader Perspectives

Recommendation 11.2: Enhance the Knowledge Institutional System of the Chemicals Industry

The state of the knowledge ecosystem of the chemical industry is dependent on the level of development of key knowledge enablers and the interaction between the enablers to create a multiplier effect. A highly developed chemicals industry ecosystem will lead to higher dynamic capabilities; resulting in higher process improvement, product development and economic outcomes.

To ensure the chemicals industry knowledge ecosystem is strong key stakeholders should map a clear strategic direction for the industry and identify the research priority areas to be developed over the next 10 years. To achieve this, it is necessary to establish an effective institutional framework for a coordinated development of the chemicals industry, leveraging on a strong partnership model with all stakeholders (federal & state government agencies, industry associations (CICM, FACS, MPMA etc), industry, community organisations and NGOs. A number of actions by different stakeholders of the industry are required:

- Increase coordination and collaboration between trade associations, government agencies, and universities to drive change in the industry.

- Promote Malaysian chemicals industry and its products in key global markets.

- Industry associations to take the lead in sustaining strong investment, especially to support frontier R&D activities.

- Industry firms must develop programs focused on Kaizen based quality improvement in automated factory environments and a culture of continuous improvement. Lean and six sigma manufacturing culture can drive operational efficiencies, and knowledge sharing. Once these foundation capabilities are in place, it is necessary to adopt programs to build advanced manufacturing skills.

Best Practice 11.2: Industry Innovation and Competitiveness Agenda

Recommendation 11.3: Develop the Knowledge Capital of the Chemicals Industry

Vocational education needs to be re-oriented to ensure sufficiency in the basic skills to deal with emerging manufacturing paradigms. Skills must be extended to create an understanding of GMP. The Kaizen and Lean Production systems are fundamental in the operation of capital intensive assets for efficient and high quality manufacture of chemicals.

Mid-level skills pertaining to continuous manufacture processes as opposed to simple batch production are fundamental in the chemicals processing industry. These skills are needed to allow a transition from the conventional batch and flow production system to advanced manufacturing systems constituted by emerging technology to enable integrated chemicals supply chains that are capable of transforming competitive platforms by an order of magnitude.

As the industry feeds into a wide range of other sectors, such as construction, agrichemicals, plastics, automotive, oil & gas, it is necessary to ensure that specialist skills in these are available to allow for innovation to take place. Close links with colleges and universities involved in chemical sciences, chemical engineering, and material sciences are needed.

Other measures can include the following:

- Encourage more students to take science courses and intensify training in basic sciences at the high school.

- Increase scholarships and other incentives for students to enrol in science and engineering related subjects in technical colleges, polytechnics and universities.

- Ensure also that those with high school diplomas can obtain training to be certified to work in the chemicals industry.

- The collaboration between educational institutions and industry should be stronger so as to ensure that training meets the needs of the industry, and there is a clear career path for students.

- Invest in large scale industrial development and R&D projects that provide internship, work placement and research (doctoral) training for students.

Best Practice 11.3: Australian Industry and Skills Committee (AISC)

Best Practice 11.8: STEM – Vision for a Science Nation

Recommendation 11.4: Develop the Knowledge Competency of the Chemicals Industry

Develop a deep understanding and develop solutions for key megatrend drivers of the chemicals industry, such as environmental sustainability, rising demand for energy and alternative energy sources and increased consumer health awareness. The following are illustrative examples:

- Biotechnology solutions: Biofuels are an attractive alternative to fossil fuels; they can help create new products from waste (i.e. agriculture waste can be turned into biomass).

- Advancements in agrichemicals can help develop a higher yield of more resilient crops to deal with the shrinking acreage of arable land.

Emerging opportunities in basic and specialty chemicals need to be investigated carefully for Malaysia. For instance, industries such as construction and housing; automotive and industrial offer strong opportunities for innovation positioning, given the rising level of urbanization taking place in emerging markets.

Specialty players focusing on selected segments have the potential to transform into highly market orientated industry specialists, who able to serve their respective customer industries with dedicated platforms, unique technologies or customized solutions. For instance:

- Polymers are one of the most important ingredients in construction chemicals. Specialty companies, such as WR Grace &Co. and RPM International have built a strong market position through focus on narrow specialism in selling ready to use liquid compounds (admixtures) to concrete mixes, either shortly before or, during mixing. The admixtures can help retard (for warmer climates) or accelerate (colder climate) setting; and reduce water content for a higher strength without increasing volume of cement.

- Similarly, for the automotive sector, specialty chemicals can enhance the look and feel of vehicles via coating; improve performance (e.g., motor oil drawing away heat from the engine chamber; rubber blacks as performance additive to tyres; structural adhesives and high performance composites in the design of car).

- Specialty chemicals for oil and gas industry to improve performance by making exploration and production more cost efficient and environmentally friendly. For example, in demulsifying agents, corrosion and scale inhibitors, etc.

Advanced manufacturing, as encapsulated in today's emerging technologies, represents an order of magnitude shift that is fundamentally transforming the manufacturing industry. It is important to adopt next generation productivity to create chemicals solutions for prevailing market needs by carefully stretching company capabilities across key strategic dimension needs and carefully investigating competencies appropriate for the Malaysian context.

Areas that currently lack economies of scale, such as specialty chemicals (plastics, paints, construction, fibres, crop chemicals, etc.) can utilize next generation smart manufacturing for cost reduction and flexible customization. Advanced manufacturing such as that featured in Industry 4.0 opens the potential to cut the cost of sales and administration, manufacturing and supply chain costs by 20-30%. This opens up entirely new platforms for competition that firms can exploit, if they are first able to master the emerging market technology.

Digital technology can enable stronger communication and collaboration across the chemicals supply chain. Complete chemicals solutions can be built through digital technologies. Companies can become true solutions providers and partners to customers rather than being suppliers or vendors. For example, a supplier of process chemicals can install sensors in dispensing equipment that allow its technical staff to optimize consumption at the customers' site. The sensors also provide process control feedback data, which can help gain ideas for optimizing the customer's company operations.

Advanced Materials Systems can help chemicals companies identify and develop innovations for maximum market impact. They can help them research the right opportunities, help in the process of designing the solutions, and innovate in the way value is captured. For instance, compilation of a database of known materials, their properties and functional uses. This can equip researchers to identify materials or material combinations (material genomics) to address specific functional needs. Such innovations can impact not only the speed of new product development but alter the nature of the process of innovation itself.

Best Practice 11.5: Driving Collaboration between Research and Industry

Best Practice 11.7: Science and Research Priorities

Recommendation 11.5: Facilitate Knowledge Learning & Transfer within the Chemicals Industry

Helping companies create new knowledge and capitalize on it necessitates a number of actions. These include:

- Identify and invest in niche areas Malaysia can lead at the regional and global level

- Support SME consolidation to allow economies of scale to prevail.

- SMEs should look to partner with large MNCs, especially specialty chemicals to develop core competencies and transfer knowledge in order to allow them to develop specialist positions within the chemicals value chain.

- Utilize developments in materials, nano- and bio-sciences to create high value applications through deeper understanding of specialist high-end requirements and understanding of future needs.

- Nurture talent in diverse range and specialist areas needed for the future of the chemicals industry, e.g. biotech and material sciences

- Develop environmentally sensitive processes for chemicals development that are safe and meet regulatory requirements, such as REACH, and assure traceability to assure quality and sustainability credentials of supply.

For the above to work, it is necessary for the Malaysian chemicals industry to establish an industry network that provides information on a wide range of areas that are strategic to the development of the firms and industry. This includes information on:

- Industrial policies;

- Legislation, regulations, best practices and standards

- Product stewardship

- Expertise, Research & Innovation

- Funding for R&D

- Networking opportunities in Europe and other continents

- Business services

Best Practice 11.4: Building SME Capability- Support for SMEs

Best Practice 11.9: CSIRO

Recommendation 11.6: Incorporate an Innovative Knowledge Approach within the Chemicals Industry

Malaysian chemical companies should follow a capabilities driven approach that focusses stringently on segment specific success factors. The more upstream the chemical company sits the more so that assets, scale and technologies are crucial. The more downstream a company is in the value chain, the more innovation, customer centricity, sales and marketing, and complexity management become important. Upstream companies need to assess their

positions in light of emerging competition, and their structural positions in terms of access to feedstock, scale, and cost. Along this part of the chain, small players will continue to face consolidation pressures as long as they remain small, non-integrated concerns with conventional manufacturing. Advanced manufacturing systems have the potential to break this deadlock, if deployed correctly.

Chemicals companies from the Middle East, China and India are now among the largest players in the world by sales. With access to economies of scale they are able to emerge as integrated players. European and American MNCs have size and assets, and many have built up specialty focus (e.g. Monsanto in GMO, etc). Malaysian firms have to position themselves strategically against the supply value chain to maximally leverage upon their strengths in the short term, and put in place measures to extend and develop their competencies and capabilities over a planned horizon.

Best Practice 11.9: CSIRO

Recommendation 11.7: Strengthen the Knowledge Leverage within the Chemicals Industry

Establish a strong industry network with a shared collective vision of overall development so as to enable the set-up of shared facility or centres to support firms in particular areas and other specialized needs within the supply chain. Sharing of resources will help create positive spill-overs in terms of cross-cutting capabilities that firms can use to benefit each other in a mutually symbiotic manner.

The chemicals industry has a spill-over impact on a number of industries, such as fertilizer, pharmaceutical, agriculture, construction and so on. Malaysian industry needs to identify and focus efforts in areas that it has competitive and comparative advantage. Universities and CoEs should work closely with firms from diverse industries to develop new applications and technology via knowledge-transfer programs.

The most effective way to ensure that knowledge and technology transfer takes place between parties (firms, government agencies and universities) is through development of a 'win-win' model; whereby industry and universities are provided incentives to work together on programs that align interests of all parties. Measures to encourage this include:

- ❑ Foster continuous learning opportunities for SMEs through affordable training programs and courses via universities, colleges, polytechnics, training institutes etc.

- ❑ Provide incentives to facilitate set-up and execution of knowledge transfer partnerships. For instance, financial support to universities for R&D, internships and work placements are given double-tax deductions and access to government grants. Such schemes begin the process of building strong relationships between participants. As parties begin to reap benefits from cooperation the partnerships become self-sustaining.

Best Practice 11.6: Research and Innovation Infrastructure

11.5 Conclusion

This chapter provided valuable information on the state of the knowledge ecosystem for the Malaysian chemicals industry. The analysis highlighted some of the key strengths and gaps in the knowledge ecosystem. In particular, the study identified the key knowledge enablers that are strong and have enabled the industry to be a major player. The empirical analysis also identified some of the weaker links in the ecosystem and key reasons for these gaps in the ecosystem. In this chapter, we also discussed key policies and strategies to strengthen the knowledge enablers so as to ensure that the dynamic capability components of the industry are raised to higher levels. Higher dynamic capabilities will translate into stronger process improvement and product development, which further, strengthen the knowledge content and economic performance of the industry.

Appendix for Chapter 11

Best Practice 11.1: PACIA

PACIA is the pre-eminent national body representing Australia's $40 billion chemistry industry, whose sectors directly employ more than 60,000 people and are responsible for approximately 11.5% of total Australian manufacturing.

PACIA's key areas of work are supported by two Advisory Councils:

- Government Policy and Regulatory Advisory Council (GPRAC)

- Leadership, Sustainability and Engagement Advisory Council (LSEAC)

Council activities focus on providing practical support and guidance across the strategic priorities set out in the PACIA Business Plan. This includes:

- Identifying and leveraging industry growth opportunities

- Communicating the industry's significance and contribution

- Influencing relevant areas of Federal and State Government policy

- Securing positive regulatory reform, and

- Developing practical programs to drive innovation and sustainability initiatives across the industry.

Coverage: From small family-owned companies and innovative medium-sized enterprises, to leading national and multinational enterprises.

PACIA acts as a:

- Business resource helping improve business performance through a variety of activities, programs and tools.

- Manages the impact of the changing State, Federal, and international environment

- One-stop-shop of important news and resources with regular member networking, information and training opportunities across the country.

PACIA activities and programs include:

1. **Industry Roadmaps**. Partnered with CSIRO and DIISRTE to conduct a study to look at the major trends likely to shape the plastics and chemicals industry and the policy responses required to meet those challenges. The report, 'Elements in Everything: Current profile and future trends for the Australian chemicals and plastics industries' is the first part of PACIA's Strategic Industry Roadmap, which sets out actions required for Australian Chemicals and Plastics industries to continue to contribute to a thriving Australian economy.

2. **In-depth Research Studies and Industry Analysis.**

   a. Example: Working with five leading industry associations, PACIA released a comprehensive analysis into the impact on industry of the unprecedented changes in Australia's gas market and its economic consequences for the manufacturing sector.

3. **Programs and Tools**

   a. The Sustainability Leadership Framework is a platform for PACIA to deliver leading edge programs, tools and policy. PACIA's Sustainability Leadership Framework helps PACIA members to focus on the key opportunities, and identifies 11 priority areas of action.

   b. The 8 Step Guide to Supply Chain Sustainability is a **dedicated online** portal with interactive and practical tools, resources and guidance

For more info: www.supplychainsustainability.org.au, http://www.pacia.org.au/ and http://www.industry.gov.au/Pages/default.aspx

Best Practice 11.2: Industry Innovation and Competitiveness Agenda

The Department of Industry, Innovation and Science consolidates the Australian Government's efforts to drive economic growth, productivity and competitiveness by bringing together industry, energy, resources, science and skills.

The department facilitates increased productivity, sustainability, competitiveness and growth of the Australian chemicals and plastics industry by fostering an environment that allows businesses to innovate and capitalise on global opportunities. The department assists other Australian Government agencies to ensure the interests of the sector are taken into account during policy development and liaises with industry stakeholders on new or changing policies.

Australia's chemicals and plastics industries provide essential materials to many other sectors, including automotive, healthcare, pharmaceuticals, education, information technology, packaging, construction and consumer appliances.

It also produces a data card on the status of the chemicals and plastics manufacturing sector which is updated regularly.

Industry Innovation and Competitiveness Agenda

The department formulates the Industry Innovation and Competitiveness Agenda- which focuses on providing the right economic incentives to enable businesses, big and small, to grow. It contains immediate reforms to boost competitiveness and a range of proposals for public consultation.

As part of this agenda a range of initiatives is implemented to enable industry to grow, increase its productivity and compete globally.

http://www.industry.gov.au/industry/IndustrySectors/chemicalsandplastics/Pages/ChemicalsPlasticsManufacturingDataCard.aspx

Best Practice 11.3: Australian Industry and Skills Committee (AISC)

The Australian Industry and Skills Committee (AISC) oversees skills development through Industry Reference Committees (IRC).

IRCs are made up of people with experience, skills and knowledge of their particular industry sector. Each IRC, supported by their skills service organisation, consults broadly across is industry to better understand the challenges and opportunities facing employers.

IRC help to ensure the occupational skills standards set out in training packages meet industry needs now and into the future. IRCs drive training package development and provide advice directly to the AISC about the skills and knowledge that should make up a nationally recognised qualification.

The AISC is focused on:

- simplifying the vocational education and training (VET) system
- making sure industry's voice is heard
- building employer's confidence in VET qualifications.

Best Practice 11.4: Building SME Capability-Support for SMEs

The Australian Government supports small to medium enterprises (SMEs) through two programmes:

- The $484.2 million **Entrepreneurs' Infrastructure Programme** offers market and industry information, business management and commercialisation advice, access to researchers and connections with supply chains and markets.
- The **Industry Skills Fund**, which commenced on 1 January 2015, has allocated $476 million to create a more effective skills and training system, with particular focus on developing employee skills.

www.business.gov.au

Best Practice 11.5: Driving Collaboration between Research and Industry

The Australian Government is taking extensive range of actions to improve the extent of collaboration between research and industry in Australia. Presented below are some of the policies that the government states it is undertaking:

- The Government has published **science and research** priorities to align areas of national research excellence with Australia's industrial strengths, global trends and community interests. Each priority is supported by practical research challenges developed in consultation with experts from industry, research organisations and government. Where there are gaps, the Government is developing options for allocating research funding to challenges requiring additional attention.
- The Government is developing simpler, more transparent **research block grant** arrangements to focus on quality and excellence, support greater industry and end-user engagement, and better engagement and knowledge transfer with industry.
- The Government is identifying further opportunities to enhance collaboration between publicly funded research agencies and industry.
- The Government has commissioned a review of **research training** arrangements to prepare excellent researchers who work productively with industry to bring their ideas to market. A highly skilled research workforce is considered vital to Australia's future prosperity.
- The Government is examining the operation of the Research and Development (R&D) Tax Incentive, within the broader context of reviewing the effectiveness of existing tax incentives for collaboration with public research institutions (as part of the tax discussion paper www.bettertax.gov.au).

- The Government continues to support national world-class research infrastructure to attract the world's best researchers and facilitate collaboration with industry. It has committed two years of operation funding to the **National Collaborative Research Infrastructure Strategy**, a critical element of the nation's innovation system

- A **Research Infrastructure Review** is currently underway. Review findings will provide a solid base for the Government to plan for national scale research infrastructure to support priority research of national significance and develop a roadmap for long-term research infrastructure investment.

- The Government is developing an intellectual property **(IP) Toolkit**, with model contracts and case studies, to facilitate collaboration between research and industry. The toolkit will ensure that dealing with intellectual property does not impede research-industry collaboration or frustrates the commercialisation of ideas.

- The Government is implementing a strategy to provide business with greater online access to research. This will allow firms to more easily identify commercially relevant research as well as potential research partners.

- The Government is looking at options to consolidate relevant research programmes which focus on industry to increase their scale and effectiveness.

- A whole-of-government policy is being developed to open business and community access to publicly funded research publications and data. Access to information about collaboration and commercialisation outcomes will improve performance in translating research into economic outcomes. To ensure real improvements in this area, the Government is working with the research sector and industry to develop a plan to improve the assessment of the research system. This will include improved metrics on engagement and knowledge transfer with industry, research outcomes, and impact.

1. www.business.gov.au

2. http://www.science.gov.au/scienceGov/ScienceAndResearchPriorities/Pages/default.aspx

3. http://www.education.gov.au/national-collaborative-research-infrastructure-strategy-ncris

4. http://www.education.gov.au/research-block-grants

5. https://www.pyneonline.com.au/media-centre/media-releases/strengthening-australias-research-training-system

6. http://bettertax.gov.au/

7. https://www.pyneonline.com.au/media-centre/media-releases/ncris-2015-16-funding-allocations-announced

Best Practice 11.6: Research and Innovation Infrastructure

A number of initiative are in place to ensure leading edge research can take place and firms have access to support facilities (equipment and expertise). Two examples of this are NCRICS and NAIF.

NCRICS

- The NCRIS facilities support a wide range of nationally significant research outcomes,

- The Australian Government allocated $300 million for the period 2015--17.

- NCRIS delivers world class research facilities, providing access to precision instruments, world class data and analytical capacity as well as high quality technical and support staff, so that Australian researchers can solve complex problems.

www.education.gov.au/ncris.

NAIF

- The Australian Government's $5 billion Northern Australian Infrastructure Facility (NAIF) investment focusses on developing northern Australian infrastructure.

Northern Australia Infrastructure Facility.

Best Practice 11.7: Science and Research Priorities

The Australian Government has developed a set of Science and Research Priorities, and corresponding Practical Research Challenges, designed to increase investment in areas of immediate and critical importance to Australia.

Faced with finite resources, making diverse investments in research across multiple agencies and many processes, is given careful thought to ensure capacity is built in research areas of particular importance to Australia.

The Industry Innovation and Competitiveness Agenda takes the position of aligning research priorities with Australia comparative advantage and corresponding practical challenges.

The Science and Research Priorities and associated Practical Challenges ensure that an appropriate level of public funding is allocated to research that addresses the most immediate problems facing Australia.

The implementation of priorities is expected, over time, to result in an increased proportion of Australian Government research investment allocated on a strategic basis to areas of critical need and national importance.

Addressing the Priorities and Practical Research Challenges requires effort from across the full spectrum of research disciplines, including the physical and life sciences, engineering, information and communications technology and the humanities and social sciences.
The Science and Research Priorities and Practical Research Challenges are reviewed every two years to allow for new initiatives to take effect and to ensure that the issues being addressed are still the most pressing for the nation.

It also requires a coordinated approach from all Government departments and agencies.

Best Practice 11.8: STEM – Vision for a Science Nation

The Australian Government is taking a whole-of-government and strategic approach in the future of science, technology, engineering and mathematics (STEM). The Government's STEM: Australia's Future outlines efforts to enhance Australian competitiveness.

STEM is considered to be critical to boosting Australia's international competitiveness and national well-being. However, STEM capabilities in Australia are at risk of falling behind major international competitors. STEM skills are recognized as being critical to the jobs of the future, and to meeting important national challenges. To address this, the Australian Government invests around $9 billion each year on science, research and innovation – in addition to investments in school education. Public investment supports research and STEM skills development in universities, organisations like CSIRO, and in businesses large and small.

In conjunction with the above, the Australian Government has established nine new Science and Research priorities to build capability in key areas and guide future investment in STEM.

Best Practice 11.9: CSIRO

Commonwealth Scientific and Industrial Research Organization (CSIRO) is key public institution conducting research and innovation across a range of industry sectors and national priorities. Starting life as the Advisory Council of Science and Industry in 1916, CSIRO has been involved in the advancement of Australian industry with a range of high impact inventions and innovations.

1. Biotechnology and Chemical solutions

One of the areas of focus of CSIRO is biotechnology and chemical solutions. In particular, CSRIO is focusing on the convergence of chemistry and biology to solve industry problems.

The aim of this group is to support long term industry competitiveness by developing resource-efficient technologies for health, agriculture, chemical processing. Examples of areas it is developing are:

- Innovative biotechnologies for people and the planet

- CSIRO is working to establish Australia as a world leader in biotechnology. It's our innovative solutions benefit agriculture, food, healthcare, environment and chemical industries.

Flow chemistry: rapid chemical synthesis

- CSIRO is developing innovative and low cost-of-entry chemical production and engineering solutions for industry, including the latest in flow chemistry technology.

RAFT: making better polymers

- CSIRO RAFT technology is a process for making better polymers with enhanced properties for use across a diverse range of areas such as health, electronics, packaging and agriculture.

2. Impact Measurement

CSIRO research and innovation activity is rigorously monitored by embedding an impact model for planning and monitoring, evaluation and reporting.

Impact model - An organisation-wide approach to planning research and managing its impact, which promotes understanding and demonstration of its real-world value.

Planning and monitoring impact - To ensure science responds to national challenges and opportunities CSIRO continually collects and analyses evidence and reports progress along the 'impact pathways' set out in its impact model.

Evaluating impact - CSIRO Strategy 2020 sets out its mission to create value for customers through innovation that delivers positive impact for Australia. Each year CSIRO provides stakeholders with robust evidence that it is achieving this goal.

Reporting impact- Regular reporting on impact and performance. That includes Annual Report and independent reviews of CSIRO's economic, social and environmental impact.

http://www.csiro.au/en/Research/MF/Areas/Chemicals-and-fibres/Chemistry-and-biotechnology
https://www.csiro.au/en/About/Our-impact

Best Practice 11.10: Australian Council of Learned Academies (ACOLA)- Understanding Progress: Broader Perspectives

The Australian Council of Learned Academies (ACOLA) combines the strengths of the four Australian Learned Academies: Australian Academy of the Humanities, Australian Academy of Science, Academy of the Social Sciences in Australia, and Australian Academy of Technology and Engineering to build a broader and more encompassing understanding on key issues.

ACOLA is a nexus for interdisciplinary cooperation to develop integrated problem solving and cutting edge thinking on key issues for the benefit of Australia. ACOLA receives Australian Government funding from the Australian Research Council and the Department of Education.

Australia's Progress in the 21st Century

Over the last decade or so numerous questions have been raised about progress and a new global movement has emerged to produce measures of societal progress that go beyond GDP, born out of a growing awareness that such macroeconomic indicators are an incomplete picture of the actual health of the economy, communities, and environment.

In Australia, a network of 50 leading community organisations, church groups, businesses and universities came together to introduce a holistic measure of progress, called the Australian National Development Index (ANDI). ANDI is an index that reflects the views of Australians in an ongoing, participatory process. Informed by experts, but defined by Australians, ANDI provides a snapshot of how Australia is doing as peoples, as communities and as a nation.

The work is carried out by the Melbourne-based Social Research Centre and helps provide a clearer picture of what Australians are thinking about progress and wellbeing and what they see as the key priorities and values for the country.

http://www.acola.org.au and http://acola.org.au/index.php/projects/securing-australia-s-future/saf13-rts-review

References

1. MATRADE. (2016a). *Chemicals & Chemicals Products.* Retrieved from http://www.matrade.gov.my/en/foriegn-buyers-section/69-industry-write-up--products/519-chemicals-a-chemical-products

CHAPTER 12

KNOWLEDGE CONTENT OF THE MALAYSIAN PETROLEUM INDUSTRY

CHAPTER 12
Knowledge Content of the Malaysian Petroleum Industry

12.0 Petroleum Industry

Malaysia is the world's second-largest exporter of liquefied natural gas (LNG) and the second-largest oil and natural gas producer in Southeast Asia (U.S. Energy Information Administration 2016; 2014). In the Asia Pacific region, it is in fourth position after China, India and Vietnam in terms of oil reserves. Malaysia has set itself the aim of becoming regional hub for oil trading and storage. Towards this end, the Malaysian Government has invested in a number of projects to increase refining and storage capabilities. For example, the new Pengerang Independent Terminals Sdn Bhd (PITSB), which is a private-public partnership with Johor State Government, will make available 1.3 million cubic meters of storage (ETP Annual Report, 2014).

In recent years, there has been a decline in Malaysia's production capacity in major oil fields, many of which are offshore. Meanwhile, domestic oil consumption has risen, thus sharply reducing the gap between oil imports and exports. This has led the Government to double its efforts in encouraging investments into deep-water fields and Enhanced Oil Recovery (EOR). To this end, Malaysia's national petroleum corporation, PETRONAS, has engaged a number of EOR projects to extend the production life of Malaysia's oldest oil fields. For example, a collaborative effort with ExxonMobil has culminated in the Tapis EOR project, off-Terengganu. The Tapis project includes seven fields: Seligi, Guntong, Tapis, Semangkok, Irong Barat, Tebu and Palas. The project is expected to extend the fields' lives by 30 years and add another 25,000 barrels per day to current production. Two more EOR projects offshore near Sarawak and Sabah are also underway as a result of an agreement between PETRONAS and Shell with investment reaching up to $12 billion over 30 years. The projects will employ the world's first offshore chemical injection process for resource recovery.

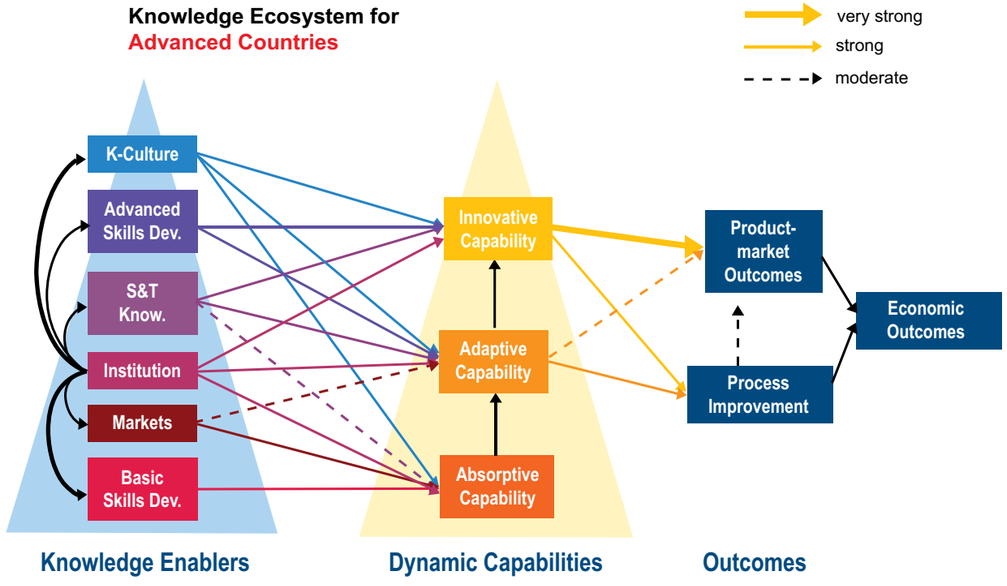
PETRONAS also offers risk service contracts (RSC) to attract new investment in small marginal fields through Enhanced Oil Recovery (EOR). In such arrangements, PETRONAS and project contractors share the risk of the venture. Exploration in deep-water offshore areas of the Sarawak and Sabah Basin has resulted in new oil and natural gas discoveries (e.g., Kikeh, Kakap and Malikai fields). Although these deep-water offshore fields pose more technical challenges, they offer new opportunities to increase domestic production and to offset the current declines of production levels from ageing fields.

12.1 Knowledge Ecosystem for the Petroleum Industry in an Advanced Country

The knowledge ecosystem of the petroleum industry capturing the intricate relationships between knowledge enablers, dynamic capabilities and economic outcomes is shown in Figure 12.1. The figure shows the petroleum industry in advanced economies to be constituted by a richness of interlinks between knowledge enablers, dynamic capabilities and outcomes. The profile for the advanced petroleum industry is particularly strong in downstream activities. Knowledge enablers of the petroleum industry ecosystem are strong and play a key role in the nurturance and development of strength in dynamic capabilities. Firms in the petroleum industries of advanced countries possess strong capabilities which they leverage to create high level process improvements and new product developments.

The knowledge ecosystem for the petroleum industry in advanced countries is characterized by a significant level of development and positive contribution to the national economy. To ensure the petroleum industry companies remain globally competitive, a considerable amount of resources is invested in human skills and leading edge research through a broad range of initiatives. Through the activities knowledge building firms in petroleum industry in advanced countries are able to build absorptive, adaptive and innovative capabilities, which helps them to innovate new products & processes. The end

Figure 12.1: Complex Relationships in the Petroleum Industry in an Advanced Country



outcome of firm capabilities is to enhance economic outcomes. Petroleum Industries in countries are characterized by the following:

- *Policies and Strategies aligned with Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Petroleum Industry* – Major global trends, such as environment protection, the emergence of alternative energy, advanced materials and sustainable development and new technologies for the exploration, extraction and development processes of the petroleum industry shape the standards of industry practice. Firms are actively involved in adjusting to emerging trends as well as shaping the industry because of their strong resource bases and deep expertise in highly specialist fields.

- *Knowledge Institutional System of the Petroleum Industry* – Institutional players, government bodies, industry associations and universities feature as active agents of change and development. They combine their perspectives and resources to develop future direction for the industry and key priority areas of development. Partnerships between the multi--stakeholders generate effective execution of policy and plans.

- *Knowledge Capital of the Petroleum Industry* –Skills are proactively planned and developed to meet future needs of the petroleum industry, in line with key shaping trends. The full spectrum of needs for upstream and downstream petroleum sectors is assessed and programs initiated to ensure requisite level of training and development take place across the petroleum supply chain.

- *Knowledge Approach within the Petroleum Industry* – Firms in the petroleum industry, even SMEs, either possess or are highly encouraged to adopt a mind-set of innovation and ready themselves to seize opportunities from emerging horizons. Firms are incentivized to invest in R&D and use advanced technology to proactively create high value added products and services for the future. Most petroleum industry operators adopt highly entrepreneurial approaches to develop solutions to generate new revenue streams. The approach to industry is highly research and innovation based.

- *Knowledge Competency for the Petroleum Industry* – There exists a well-defined map of the skill set needed by the industry. This is complemented by a systematic framework for tracking progress across the changing landscape of the industry.

- *Knowledge Learning & Transfer within the Petroleum Industry* – Knowledge and innovation networks are formalized to bring together businesses, entrepreneurs, academics, funding agencies to ensure knowledge is shared. Well integrated frameworks are in place to develop key priority areas to create the necessary flows of S&T and R&D. Agencies and infrastructure are efficiently connected to ensure spill-over benefits are fully reaped by industry.

- *The Petroleum Industry Ecosystem has in place strong Knowledge Leverage mechanisms.* Institutions (government agencies, industry association and educational institutions) play a key role in establishing platforms and forums of exchange of information and knowledge to firms in the industry. Specific platforms and infrastructural facilities ensure all players in the industry, especially entrepreneurial SMEs, are able to access advances in technology, R&D and other knowledge to improve their operations and develop high value-added new products and services.

Examples of best practices of the above are detailed in the chapter appendix.

12.2 Knowledge Ecosystem of the Malaysian Petroleum Industry

In this section, we provide a brief description of the knowledge ecosystem for the Malaysian petroleum industry based on survey evidence. The survey is comprised of 19 large and 36 small firms, giving a total of 55 firms; of these 23 are foreign and 32 are local. Figure 12.2 show the state of development of knowledge enablers. Most enablers exhibit moderate performance. Notable weakness is observed in institutions and to some extent in markets and S&T knowledge.

Figure 12.3 show the dynamic capability components, process improvement and product development in the Malaysian petroleum industry vis-à-vis the position of an advanced country. The dynamic capability components, process improvement and product development were measured for large firms, SMEs, local firms and foreign firms. Dynamic capabilities, process improvement and product development for advanced countries are significantly higher than that of the Malaysian petroleum industry, even though the Malaysian petroleum industry is a strong exporter of petroleum and petroleum derivative products. Foreign firms established in Malaysia exhibit similar levels of

Figure 12.2: Knowledge Enablers for the Malaysian Petroleum Industry

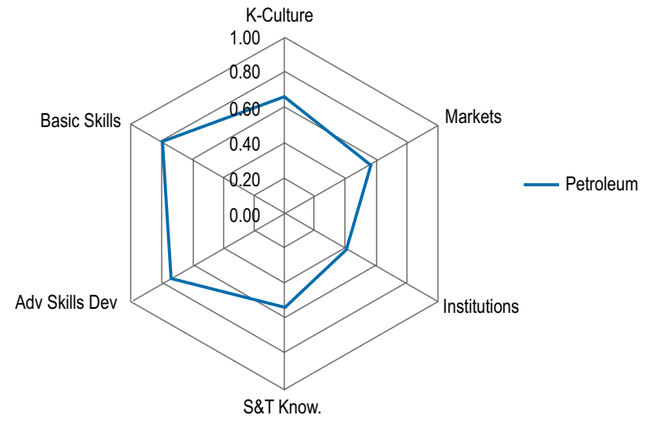
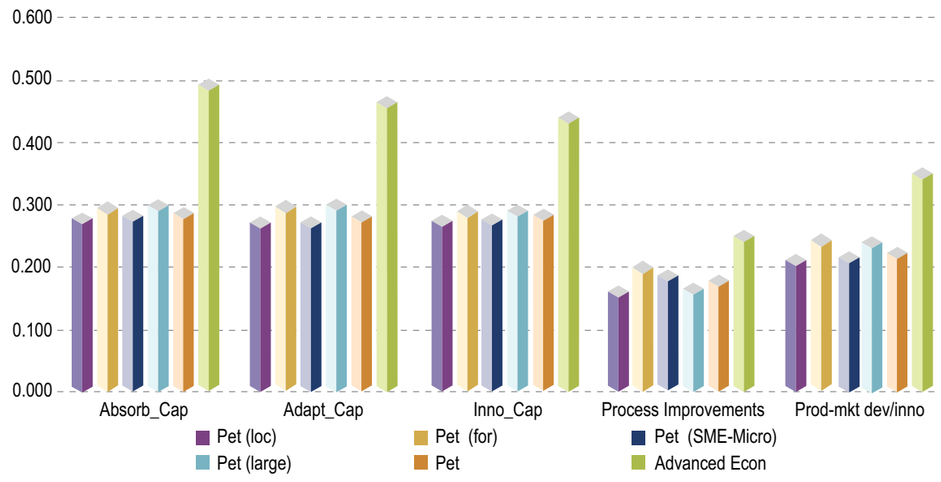


Figure 12.3: State of the Dynamic Capabilities of the Malaysian Petroleum Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

Figure 12.4: Strategic Posture of the Firms in the Malaysian Petroleum Industry

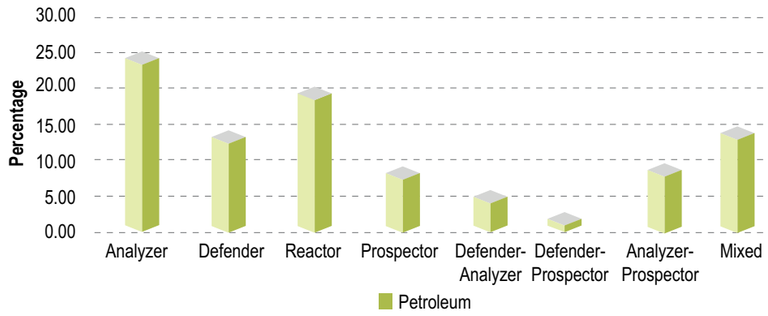
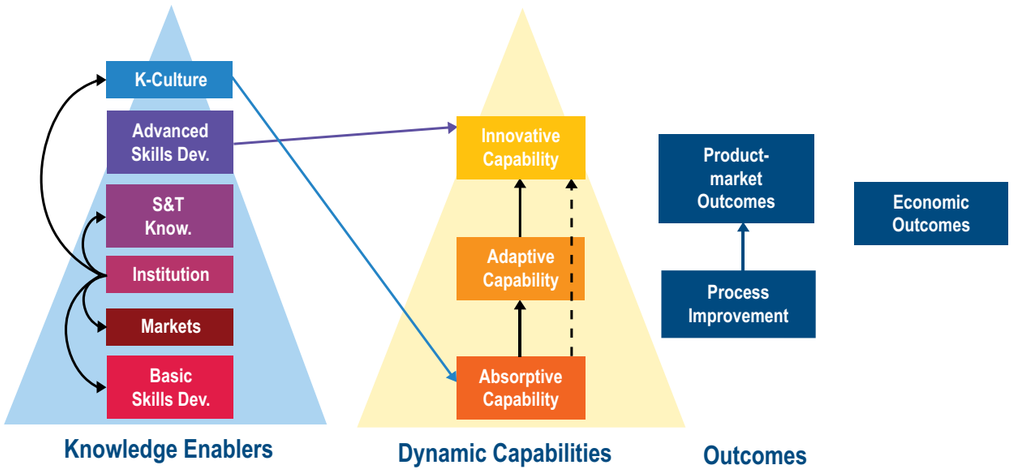


Figure 12.5: Knowledge Ecosystem of the Petroleum Industry



dynamic capability and product development to those o local firms. Larger firms are marginally stronger across all dimensions than smaller firms.

The strategic postures of firms in the Malaysian petroleum oil industry are given in Figure 12.4. The figure shows that a just over 25% of firms are Analysers followed by the 20% of Reactor firms. Prospector firms are below 10% suggesting that only a small proportion of firms in the petroleum industry engage in any notable way with R&D activity. Reactor firms are sizeable in number. This raises worrying concerns over the ability of firms in the industry to survive disruption, such as cheaper shale oil, the volatility in prices and instability in the Middle East that is currently experienced by the industry.

The knowledge ecosystem for the petroleum industry is shown in Figure 12.5. The Malaysia petroleum knowledge ecosystem is weak compared to ones observed in more advanced countries. Institutions in the Malaysian ecosystem play only an indirect role in developing knowledge enablers. Worryingly institutions exhibit no significant direct effect on any dynamic capabilities. This suggests that firms in the petroleum industry are not benefitting significantly and directly from institutional provisions, even if such provisions do exist. Knowledge culture does appear to help in the nurturance of absorptive capability, and positively advanced skills play a significant positive role in the development of innovative capability.

The almost total absence of significant links from enablers to firm level dynamic capabilities compared to that observed in industries in advanced countries is indicative of the fact that the local petroleum industry is not itself innovative but is heavily reliant on others' technological advances. This suggests that the knowledge ecosystem is weak despite the scale of capital investments. In advanced countries, institutions play a strong indirect and direct role in developing firm capabilities. Unfortunately, in Malaysia, the other knowledge enablers also fail to significantly surface in the development of dynamic capabilities. Only advanced skills and knowledge culture do so.

Overall the evidence suggests a weak knowledge ecosystem which fails to substantially propel Malaysian petroleum industry players into leadership positions within the industry. Malaysian operations in the petroleum industry are dependent on partnerships with global players. Price is the major competitive weapon, which is a notable characteristic of the upstream commodity crude oil and gas output. The findings corroborate the view that that Malaysian petroleum industry remains dominated by the upstream commodity extraction. Malaysian petroleum firms, with rare exceptions, have struggled to successfully transition to high value mid-stream and downstream products. The inability of knowledge enablers in the ecosystem, and in particular institutional enablers to significantly improve the condition of the petroleum industry, raises structural concerns over the long term viability, especially of smaller players.

12.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Petroleum Industry

Based on the analysis of the knowledge ecosystem of the petroleum industry, the key strengths and gaps of the ecosystem are provided in this section of the report.

Key Strengths of the Petroleum Ecosystem:

- Malaysia has the 28th largest reserves of crude oil and 16th largest natural gas reserves in the world.

- Given the natural resource strength, there has been strong support from the Malaysian government to develop the petroleum industry as a major revenue earner for the country. This has helped the industry become a global player in petroleum.

- Malaysia has committed extensive investment in integrated petrochemical complexes that offer efficient storage and transportation network to reduce operational costs and improve returns. Pengerang Integrated Complex, currently being developed by Petronas, is an example of a work class facility being built in Pengerang Johor.

- The industry receives strong support from the government in terms of financing for R&D, infrastructure, development and capability development (basic and research personnel). Malaysia has supplemented these efforts through the establishment of universities focused on petroleum and derivative fields.

- In addition to PETRONAS, Malaysia's attractive FDI terms has attracted major petroleum and petrochemicals firms (SHELL, BASF, Toray, etc.) to set up local operations. Investments into petroleum and petrochemicals from Germany, Japan, Netherlands, US and Korea have been significant, and helped to strengthen the sector.

- Large industry players have the resources and capability to undertake R&D to create new products and services, and a number of the top players (especially MNCS) have used these to good effect in penetrating end-use markets.

- Malaysia has managed to build strong partnerships with ASEAN countries, such as Thailand, Vietnam and Indonesia to secure the gas supply for Malaysian operators reliant on the feedstock.

Key Gaps Petroleum Knowledge Ecosystem:
A number of gaps in the knowledge ecosystem can be identified. The key gaps and associated issues are summarized below.

Basic Skills Gap

- Training and development of basic skills is a fundamental component in the industry to allow the industry to transition to higher value propositions across the supply chain.

- However, there is a need for skills development to be directed beyond office work and it needs to be more carefully designed to cater for work taking place in the effective functioning of plants, machinery and rigs.

- Experiential learning is an important part of knowledge capture and use in complex machinery and operations in the oil and gas sector. Unless vocational skills are recognized and rewarded, the sector will continue to struggle in its oil and gas operations, due to the high turnover of skilled operators of machines and equipment.

Advanced Skills Gap

- There is a shortage of staff with sufficient advanced knowledge and skills to reconfigure and apply knowledge for novel and innovative outcomes.

- Businesses, especially local SMEs, do not invest sufficiently in R&D or innovation. Highly talented individuals do not wish to be employed by such firms, and instead look for opportunities that allow them space to experiment and engage in challenging work.

- Strong disconnects within the supply chain and ecosystem of the industry due to a lack of appreciation as to how collaboration with universities conducting frontier R&D can lead to high innovation pay-offs.

Market Knowledge and Intelligence Gap

- The petroleum industry has been subjected to increasingly volatile conditions that have adversely affected the commodity's price due to factors such as overproduction, cooling demand and intense price competition from OPEC nations.

- The industry has shown a lack of preparedness for market and technological shocks to the system. Recent developments in shale gas, as well as political instability in the Middle East are examples that expose vulnerabilities of the sector. The situation is worsened by the declining production capacity of many Malaysian oil fields and the difficulty in prospecting new wells.

- A diversified portfolio with competencies that stretch upstream into high value added products is needed to cushion impact of system shocks. This would allow time for adjustment rather than defensive reactions.

Institutional Support Gap

- Attempts by regulators and industry agencies to create enabling environments are numerous. However, they have not managed to materialize the much wished for transformation of the industry as advanced high value player in mid-stream and downstream operations, beyond the national giant of the industry, Petronas, and a small network of suppliers around it. Petronas has set up educational programmes to service the needs of the industry, but the effects of these have not trickled down sufficiently to materialize positive ripple effect within the supply chain.

- Lack of direct institutional impacts is surprising, given the amount and range of support rendered to the industry. This suggest serious coordination and/or communication issues.

S&T Gap

- In the petroleum industry, only 8% of Malaysian companies actually own proprietary technological IPs. Save for a few niche areas, the industry possesses a largely dormant R&D ecosystem that requires considerable strengthening before it is able to engage in market-leading innovation.

- Purchase of technologies and machinery from foreign countries, without sufficiently explicit clauses for knowledge transfer creates long term dependencies. This dependency also constrains local firms' ability to build process improvements, or create novel products through process capability enhancement.

- When this is coupled with a shortage of a skilled technical workforce to adequately tackle the demands of complex machinery maintenance, achieving an optimal leverage of knowledge becomes problematic.

Knowledge Ecosystem Gap

- Firms along the full spectrum of the supply chain fail to adequately galvanise together around key challenges to optimize high value delivery ecosystem.

- Weak collaboration with local universities and international research institutions limit the virtuous cycle of knowledge absorption, creation and application.

- Despite numerous programmes, Malaysia's 'triple-helix' remains weak, and there is a strong disruption in the integrated flow of advanced skills to develop adaptive and innovative capabilities within the petroleum supply chain. Most firms in the petroleum industry are simply users of new technology and innovations; they are not producers of cutting-edge innovations.

12.4 Recommendations to Improve the Malaysian Petroleum Industry Knowledge Ecosystem

The petroleum industry is a leading contributor to the Malaysian economy. Malaysia is blessed with an abundance of natural oil and gas resources, which it has actively used for the benefit of national development. Making progress in a complex and capital intensive sector has required Malaysia to provide partnership rights of exploration and exploitation to big multinationals. This mutually beneficial arrangement has worked well in generating returns. However, progress in capability building of mid-stream and downstream players along the value chain of the industry has not materialized to the level of expectation. This raises concerns for future viability, especially as industry undergoes uncertainly and system level shocks with the emergence of shale oil and highly volatile markets. To ensure strength and viability of the industry, the following recommendations are proposed to strengthen the knowledge ecosystem of the industry.

Recommendation 12.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Petroleum Industry

Establish a high-level panel consisting of key stakeholders to examine and review existing strategic master plans and associated initiatives for the petroleum industry and align them through regular review with emerging issues and trends, such as shale oil and crude oil volatility. Develop a strategic outlook that is able to handle system shocks by ensuring that the petroleum industry risk portfolio is balanced. A number of steps can be taken in the creation of a conducive environment for innovation, such as:

- Strong partnership between industries to ensure nurturance of the ecosystem. This requires strategic alignment of the upstream and downstream industries to create win-win partnerships to flourish. This requires deep careful understanding of the trends and needs of downstream industry.

- Engage proactively in standards of best practice in the industry. It is necessary to work closely with key institutions to comply with and also develop standards. For example, the API in the States (American Petroleum Institute (one of the leading globally recognized standards setting boards in oil and gas industry).

- Develop advanced skills and competencies as encapsulated in Industry 4.0 or Smart Industry.

- Develop a programme for environmental sustainability to improve industry credential and performance to highest standards of social responsibility.

- Adopt an Integrated ecosystem approach to encourage and attract greater R&D initiatives, innovation and development of new product and technology from within and across the industry.

Best Practice 12.1: Sustainability Good Practices: IPIECA's Climate Change Reporting Framework

Best Practice 12.4: Norway: Petroleum- An industry based research and development

Recommendation 12.2: Enhance the Knowledge Institutional System of the Petroleum Industry

Establish an effective institutional framework for a coordinated development of the petroleum industry, leveraging on a strong partnership model with all stakeholders (federal & state government agencies, industry associations, industry, community organisations and NGOs) in the industry. Steps to facilitate this include:

- Purposely work to increase coordination and collaboration between trade associations, government agencies, and universities to drive change in the industry. Role of bodies such as MPRC is key in ensuring strong alignment and execution.

- Promote Malaysian petroleum industry and its products in key global markets.

- Industry association should take the lead in sustaining strong investment, especially to support frontier R&D activities along with big players.

- Educational institutions need to interact with industry and develop robust programs to create specific skills sets for current and future needs. This requires a close working relationship between the various stakeholder parties.

Best Practice 12.4: Norway: Petroleum- An industry based research and development

Recommendation 12.3: Develop the Knowledge Capital of the Petroleum Industry

A comprehensive talent and skills management strategy needs to be formulated to fill gaps in current skills. Future skill needs must be mapped out and actions taken to develop quality and quantity of skills for long term success. Some required initiatives for this are:

- Vocational education needs to be re-oriented to ensure there is sufficiency in skills to deal with petroleum industry operations. This is needed to allow a transition of the industry from conventional industry to one reliant on emergent types of skill sets that are needed by upstream and downstream sections of the oil and gas supply chain. At the same time, it is necessary to enhance and strengthen existing vocational skills in automated machinery operations and technical understanding of the machinery, equipment maintenance, handling oil and gas storage and flow manufacturing processes.

- Develop mid-level skills pertaining to continuous manufacture processes and emerging advanced operations technologies. A high level of understanding of GMP, Kaizen and Lean Production is key to efficient use of capital assets. Close links with colleges and universities involved in petroleum engineering, materials and polymer chemistry are needed to tap in pool of graduates who have strong grounding to enter into the petroleum industry.

- Intensify TEVT training with Petroleum Science as a major in high school (SPVM), technical colleges and polytechnics, by working closely with major industry players.

- Promote the industry to the younger generation through proactive engagement of industry with colleges and schools through career talks and role models.

- Institute mentorship and internship programmes to ensure practical exposure of undergraduates to industry practices.
- Active promotion of diverse range of careers in the petroleum industry is needed to ensure a steady supply of people willing to work on oil rigs and harsh environments. Specific programs must be designed to attract the younger generation, who are likely to be the future workforce.

Best Practice 12.1: IPAA and PESA Preparing Next Generation Leaders

Recommendation 12.4: Develop the Knowledge Competency of the Petroleum Industry

- A definition of strategic priorities needs to be complemented with efforts to develop necessary competencies. Beyond mapping industry future scenarios and competencies, a number of actions are needed. These include:

- Developing key areas such as deep water technology, enhanced oil recovery, advanced engineering technology, hybrid technologies, nano-technologies and materials and chemicals sciences, geo-sciences, as well as expertise in related social sciences, such as oil & gas law.

- Incentivise universities and research institutes to develop specific areas of expertise, relevant to the needs of the industry. Close collaborations with local universities specializing in oil and gas fields, such as UTP, UCSI, as well as international centres of excellence (e.g. Herriot-Watt, UK, UQ, Australia).

- Increase scholarship programmes in specialized areas required by the industry to meet future skills, knowledge and talent needs. The spread of scholarships should ensure the right distribution of breadth and depth of skills is available for industry; from technical and vocational skills to post-doctoral researchers with advanced specialisms.

Best Practice 12.3: BP partners with the University of Texas on leading-edge energy research

Best Practice 12.4: Norway: Petroleum- An industry based research and development

Recommendation 12.5: Facilitate Knowledge Learning & Transfer within the Petroleum Industry

The most effective way to ensure that knowledge and technology transfer takes place between parties (firms, government agencies and universities) is through the development of a 'win-win' partnerships; where industry and universities are provided incentives to work together on programs that align the interests of all parties. Some of the steps needed in this process are:

- Provide incentives to facilitate set-up and execution of knowledge transfer partnerships. For instance, financial support to universities for R&D, internships and workplace given double-tax deductions and access to government grants. Such schemes begin the process of building strong relationships between participants. As parties begin to reap benefits from the cooperation the partnerships become self-sustaining.

- Partnership with big MNCs are needed to establish a strong industry network with shared collective vision of overall development so as to enable set-up of shared facility or centres to support firms in particular areas and other specialized needs within the supply chain. Sharing of resources will help create positive spill-overs in cross-cutting capabilities that firms can use to benefit each other in a mutually symbiotic manner.

- Foster continuous learning opportunities for SMEs through affordable training programs and courses via universities, colleges, polytechnics, training institutes etc.

- Increase trans-sectoral and transnational mobility to promote international and inter-sectoral acknowledgement of certificates and training courses, including work mobility programmes to encourage skills development.

- Identify specific areas of knowledge transference and engage in partnerships with leading industry players in identified key research focus area. This involves evaluating their willingness to engage in positive win-win arrangements. It is necessary to create strong learning and knowledge partnerships with MNCs operating in Malaysia and, within these, incorporate explicit clauses for knowledge transfer.

- Be aligned with the major movements that impact the sectors, such as move towards sustainability and environmental protection in running operations. This helps build strong position in the mind of end consumers of the petroleum industry based products.

Best Practice 12.4: Norway: Petroleum- An industry based research and development

Best Practice 12.5: ADNOC and the Petroleum Institute - Internal Preparedness for Knowledge transfer

Recommendation 12.6: Incorporate an Innovative Knowledge Approach within the Petroleum Industry

A strong entrepreneurial and innovative mind-set must prevail within the industry. An outward expression of this is the level of importance and investment in R&D. To encourage this, appropriate incentives for R&D must be devised to ensure the process is vibrant and active. To institute this an innovation taskforce can be set up to evaluate the potential of past technology investments, and administer incremental knowledge improvements and skills extension within the industry. A good knowledge strategy to follow would be to encourage investment in focused areas of R& as well create a portfolio balanced with high risk projects. Accompanying steps include:

- Develop mechanisms to compile and analyse comprehensive data (e.g. oil and gas production, shipments, inventory, import and export and consumption trends). These feed into the decision-making process to strengthen global competitive position.

- Use advanced technology (e.g. Data Analytics) to make improved decisions and hence balance the risk return portfolio.

- Use advanced technologies to gain more feedback from operations and hence open up possibilities for innovation. For example, one can set up a continuous live feedback loop rather than post hoc feedback to improve deep sea extraction efficiency.

- Intensify the use of Industry4.0 to improve greater efficiency, productivity, interaction and innovation. At the same time, look at the spectrum of areas where Malaysia firms can stretch their current competencies and develop stronger niches of advantage by working more closely with current end-market players

Best Practice 12.6: Schlumberger- Research and Technology as a driver of success

Recommendation 12.7: Strengthen the Knowledge Leverage within the Petroleum Industry

In order to leverage on the strong petroleum industry in Malaysia, resources should be channelled to develop key technology platforms that will further spearhead the industry. This can be achieved through a number of actions, such as:

- Nurture talent across a diverse range of specialist areas needed for the future of the Petroleum industry and provide them with industry experiences that build deep expertise. Create strong links between industry and research institutions by developing a premise for building collaborative economies of scale and specialized areas for innovation.

- Identify and invest in downstream niche areas Malaysia can lead at the regional and global level. Scrutinize key downstream industries (plastics, auto, construction, chemicals), and identify potential areas of opportunity to fulfil special needs or customer customization.

- Utilize developments in materials, nano-engineering and bio-sciences to create high value applications through deeper understanding of specialist high end requirements for oil and gas exploration and end use applications.

- Ensure specialist skills in key core areas are strong, such as petrochemical engineering, geoscience, biotech and material sciences. This also applies to support service functions (e.g. oil rig engineering and maintenance, etc.).

- Support SME consolidation to allow economies of scale to prevail.

- SMEs to partnership with large MNCs, to develop specialist knowledge and applications.

Best Practice 12.3: BP partners with the University of Texas on leading-edge energy research

Best Practice 12.4: Norway: Petroleum- An industry based research and development

2.5 Conclusion

This chapter provided valuable information on the state of the knowledge ecosystem for the Malaysian petroleum industry. The analysis highlighted some of the key strengths and gaps in the knowledge ecosystem. In particular, the study identified key knowledge enablers that are strong and have enabled the industry to be a major player. The empirical analysis also identified some of the weaker links in the ecosystem and key reasons for these gaps in the ecosystem. In this chapter, we also discussed key policies and strategies to strengthen the knowledge enablers so as to ensure that the dynamic capability components of the industry are raised to higher levels. Higher dynamic capabilities will translate into stronger process improvement and product development and strengthen the knowledge content and economic performance of the industry.

Appendix for Chapter 12

Best Practice 12.1: IPAA and PESA Preparing Next Generation Leaders

The Independent Petroleum Association of America and the Petroleum Equipment & Services Association is committed to education outreach through its Houston-based Energy Education Centre.

To achieve its aims, the next generation of America´s oil and natural gas leaders is being mentored toward securing successful careers within the energy industry. Five Petroleum Academies have been established for junior level students:

- Energy Institute High School, Houston
- Milby High School, Houston
- Southwest High School, Fort Worth
- Westside High School, Houston
- Young Women's College Preparatory Academy, Houston

The mission of the petroleum academies is to provide students with a multidisciplinary, advanced academic learning experience in science, mathematics and the emerging technology concepts needed to pursue professional training and degrees in engineering, geology, geophysics and global energy management in the oil and natural gas industry.

IPAA and PESA are achieving an unprecedented level of success by reigniting student interest in Science, Technology, Engineering and Mathematics (STEM).

Best Practice 12.2: Sustainability Good Practices: IPIECA's Climate Change Reporting Framework

Sustainability has become a major issue for many industries. The petroleum industry is no exception. Indeed, the sustainability credentials of petroleum players are closely scrutinized by the public and NGOs. This has led to many of the leading players adopting a proactive approach to the issue.

An example of good practice reporting is IPIECA's Climate Change Reporting Framework. This is a guide for the oil and gas industry. It provides the fundamentals of biodiversity and ecosystem services and serves as a guide document for the oil and gas industry. The BES Fundamentals guidance document brings together information essential to informing BES strategy development and decision making at the corporate level and at the key stages of an asset life cycle for any type of operation or environmental context. The document sets out a management framework comprised of six interrelated BES management practices along with an overview of tools for application within these practices, case studies of how these are being applied, and references for more detailed guidance.

Best Practice 12.3: BP Partners with the University of Texas on Leading-Edge Energy Research

1. BP funds about $100 million in university research, education and recruitment activity at more than 50 US universities annually.
2. In the US alone, BP annually hires over 700 students and graduates in the US for full-time and intern positions from more than 10,000 applicants.
3. BP supports several multiyear research programs on subjects ranging from advanced computing and bioscience to unconventional gas, heavy oil, and rock physics.

BP and University of Texas

- In 2013 BP launched a new strategic partnership with The University of Texas at Austin to support several leading-edge oil and gas industry research projects.
- The collaboration highlights BP's ongoing commitment to higher education and research, and aims to develop real-world solutions to a number of technical challenges facing the global oil and gas industry, both onshore and offshore.
- Example: Project 20K™, a multi-year initiative announced by BP that seeks to develop next-generation systems and tools to help unlock the next frontier of deepwater oil and gas resources, currently beyond the reach of today's technology. Accessing these resources is a key part of BP's commitment to US energy security.

Work with Department of Electrical and Computer Engineering

- The University of Texas' Department of Electrical and Computer Engineering works with the Project 20K™ team to study the impact of "human factors" on the drilling process and the potential for new systems that can enhance safety and efficiency.
- It is administered by a joint governance board. The program has established a rigorous process for selecting research projects that play to the university's world-class strengths in engineering and geosciences as well as meet BP's strategic business needs.
- "This is not just theoretical research," said James Dupree, BP's Chief Operating Officer, Reservoir Development & Technology. "Under this partnership, we are tackling real-world challenges that, if better understood, could have far-reaching impacts not only on BP but on the future of global energy development."
- Successes in early projects will help build the basis for future collaboration, with the ultimate goal of taking the research and technologies developed through the program from the lab and into the field.

Best Practice 12.4: Norway: Petroleum - An industry based research and development

The petroleum industry is one of Norway's largest and most important industries.

Research and Technology Development in the Petroleum Sector

The development of new knowledge and technology is a cornerstone of Norway's energy resource management.

- Ever since Norwegian petroleum activities began, efforts to find the most efficient solutions for exploration, field development and production of Norwegian oil and gas have been based on research, development and demonstration of new technology. New technology has been essential to achieving the greatest possible value creation and environmentally sound utilisation of resources on the Norwegian continental shelf.
- Today, the Norwegian petroleum industry has state-of-the-art expertise and mastery of a wide range of new technologies, and is capable of tackling large, complex projects. The industry's competitiveness and innovation capacity have also led to major positive spin-off effects and technological applications in other industries in Norway. Technology developed for the Norwegian shelf has given the Norwegian supplier industry a competitive advantage on the global stage.

Ministry of Petroleum and Energy and Norway Research Council

The Ministry of Petroleum and Energy established the strategy "Oil and Gas in the 21st Century" (OG21) in 2001 to address the challenges associated with efficient and responsible petroleum activities.

The OG21 process has helped oil companies, universities, research institutions, the supplier industry and the authorities to agree on a joint national technology strategy for oil and gas. The strategy has been revised several times, most recently in 2012, and is to be revised again in 2016.

Additionally, favourable EU framework conditions have given companies incentives to carry out research and technology development. Close collaboration between oil companies, suppliers and research institutions has underpinned the successful development of new technology and solutions.

Norway authorities encourage research and technology development primarily through legislation or other forms of regulation and through direct allocations to the Research Council of Norway. Most of these allocations go to the PETROMAKS 2 and DEMO2000 research programmes and to research centres in Stavanger and Tromsø. These programmes and centres are intended to play a part in achieving the objectives set out in the OG21 strategy.

1. **PETROMAKS 2**

   The PETROMAKS 2 programme promotes knowledge creation and industrial development to enhance value creation for society by ensuring the development and optimal management of Norwegian petroleum resources within an environmentally sustainable framework. The programme supports research and technology development for enhancing recovery from fields in production, exploration in immature areas, raising energy efficiency, reducing emissions and research on HSE-related activities.

   PETROMAKS 2 provides funding to a broad range of projects, from strategic basic research at universities and research institutes to innovation projects headed by the private sector. The PETROMAKS 2 programme is an important funding instrument used to promote long-term research and competence-building, and is focusing strongly on education in the programme period, for example by funding PhDs.

http://www.forskningsradet.no/prognett-petromaks2/Home_page/1253980921309

2. **DEMO2000**

   The DEMO 2000 program is an initiative supported by the Ministry of Petroleum and Energy (MPE) in order to ensure long term competitiveness in the oil and gas business and continued profitable development of the petroleum resources of the Norwegian Continental Shelf.

   The program also aims to develop innovative Norwegian industrial products, systems and processes for the global offshore market. The steering group for the program consists of representatives from oil companies, service industry and research institutes.

3. **PETROSENTERS- Research Centres Engaged in Petroleum Related Activities**

   ARCEx - Research Centre for Arctic Petroleum Exploration

   In 2013, a high-quality research and knowledge centre was established at UiT the Arctic University of Norway to address issues of relevance to the oil industry in the Arctic. ARCEx is funded jointly by the Ministry of Petroleum and Energy and the Ministry of Foreign Affairs.

   The National IOR Centre of Norway

   In 2013, a research centre for improved oil recovery was opened at the University of Stavanger. The centre contributes to industry-relevant research, researcher training and long-term competence-building for improved recovery on the Norwegian shelf.

   It also facilitates cooperation between the industry and research communities so that new solutions can be rapidly deployed. Improvement of existing recovery methodologies and development of new ones are key focus areas.

Other Research Centres and Programmes

Norway Research Council has launched several Centres for Research-based Innovation (SFI) as well as Centres of Excellence (SFF). A number of these centres carry out petroleum-relevant research, including:

- Multiphase Flow Assurance Innovation Centre (FACE) at SINTEF/IFE
- Centre for Integrated Operations in the Petroleum Industry at NTNU
- Drilling and Well Centre for Improved Recovery (DrillWell) at IRIS
- Sustainable Arctic Marine and Coastal Technology (SAMCoT) at NTNU
- Centre for Autonomous Marine Operations and Systems (AMOS) at NTNU
- Centre for Arctic Gas Hydrate, Environment and Climate (CAGE) at UiT the Arctic University of Norway.

The SFI centres can receive funding for up to eight years, and the SFF centres can receive funding for up to ten years. In 2014, funding was allocated to a total of 17 new SFI centres with start-up in 2015. A number of these are focused on petroleum industry, such as:

- Subsea production and processing (SUBPRO) at NTNU
- Centre for Offshore Mechatronics at the University of Agder
- Centre for Integrated Remote Sensing and Forecasting for Arctic Operations at UiT the Arctic University of Norway.

Source: Research Council of Norway.

http://www.forskningsradet.no/en/Home_page/1177315753906

http://www.forskningsradet.no/en/Priority_initiatives_for_2017/1253990809116

http://www.forskningsradet.no/en/Energ_Resources_and_the_Environment/1253964135199

http://www.forskningsradet.no/en/Petroleum_Research/1253964136578

http://www.norskpetroleum.no/en/environment-and-technology/petroleum-related-research-and-development/

http://www.forskningsradet.no/servlet/Satellite?c=Page&cid=1228296770594&p=1228296770594&pagename=gassmaks%2FHovedsidemal

Best Practice 12.5: ADNOC and the Petroleum Institute - Internal Preparedness for Knowledge transfer

Abu Dhabi has embarked on a major oilfield research and development push.

The expansion reflects a major departure in R&D for both ADNOC and the Petroleum Institute, which includes a specific mandate for the institute to come up with ways to add 5 per cent – or about $500bn of value – to Abu Dhabi's oil reservoir recovery rates, according to the Petroleum Institute president Thomas Hochstettler.

"The new strategy is to ensure that PI can contribute to and benefit from projects," Mr Durandeau said. "Before the contribution to projects we were funding maybe 5 per cent – just someone travelling once a year to see some people in a university. For me this money was not well spent. It was more like a donation."

The approach did not made commercial sense for Adnoc either. As Mr Durandeau explained, the state oil company had largely relied on its private sector partners – including Total, as well as BP, Shell and Exxon – for advanced field development technology that they have developed elsewhere in the world where conditions may not be applicable.

“Adnoc has the same problem we have,” Mr Durandeau said. “If you don’t do your own research you have to rely on that which is produced outside.
“Big companies are coming here to get concessions and to get them they offer new technologies. But if you don’t have good knowledge of the capabilities and suitability of the technology how can you make the business case? If you don’t have your own in-house knowledge it is difficult to assess what you need.”

The new centre will be central to Adnoc’s new system, whereby each of its operating companies will have R&D units focused on deploying R&D in field conditions. The initiative also marks a new level of academic maturity for the 15-year old Petroleum Institute.

Adnoc’s strategic partners are part of the process with BP, Shell, Total and Japan Oil Development Company (Jodco) helping to fund the research centre.

amcauley@thenational.ae

Best Practice 12.6: Schlumberger - Research and Technology as a driver of success

The search for oil and gas has three objectives: to identify and evaluate hydrocarbon-bearing reservoirs; to bring hydrocarbons to the surface safely and cost-effectively, without harming the environment; and to maximize the yield from each discovery. These objectives can be advanced only by ongoing research into all aspects of the exploration, drilling, and production processes.

Since its inception in 1927, Schlumberger has consistently invested significant time and money on research and development as a long-term strategy to support and grow its technology leadership. Schlumberger places strong emphasis on developing innovative technology that adds value for its customers. Schlumberger consistently invests more in R&D each year than all other oilfield services companies.

Schlumberger maintains its commitment to technology and innovation through an extensive network of technology and research centres, which include the following key facilities.

Technology Centres

- Abingdon Technology Centre
- Beijing Geoscience Centre
- Montpellier Technology Centre
- Schlumberger Kabushiki Kaisha Centre
- Schlumberger Information Solutions Norway

Technology Centre

- Schlumberger Rosharon Technology Centre
- Schlumberger Riboud Product Centre
- Software Technology Innovation Centre
- Stonehouse Technology Centre
- Sugar Land Technology Centres

Research Centres

- Schlumberger Brazil Research & Geoengineering Centre
- Schlumberger Dhahran Carbonate Research Centre
- Schlumberger-Doll Research Centre
- Schlumberger Gould Research Centre
- Schlumberger Moscow Research Centre
- Schlumberger Stavanger Research Centre

Example: Schlumberger Abingdon Technology Centre: Technology led collaboration and global knowledge sharing

Through collaboration with universities in the UK, USA, and France, as well as an internship program, AbTC promotes relationships with universities around the globe. Employees at all levels benefit from a continuous training program, tailored career management, extensive electronic library facilities, and a global structure that supports knowledge sharing and teamwork. Management encourages patent applications, conference participation, and journal publications.

Best Practice 12.7: Schlumberger - Digital Innovation for Oil and Gas Industry

Software Technology Innovation Centre

Schlumberger Software Technology Innovation Centre (STIC), established in 2014, is focused on the innovative application of software technology that will lead the industry’s cloud platform transformation supporting efficient, reliable, and predictable real-time end-to-end workflows accessible from anywhere at any time.
Uniquely positioned in the heart of the Silicon Valley at Menlo Park, California, STIC is located in the vicinity of major players in the software industry and the Stanford University campus.

STIC collaborates closely with the numerous Schlumberger technology centres around the world, and with leading software industry partners and universities, to jointly develop software technology solutions to support the Schlumberger business and E&P customers.

STIC targets a wide array of software technologies including high performance computing, cloud, big data, analytics, internet of things (IoT), industrial internet, visualization and user experience.

http://www.slb.com/about/rd.aspx

References

1. U.S. Energy Information Administration. (2014). *Malaysia*. Retrieved from https://www.eia.gov/beta/international/analysis.cfm?iso=MYS

2. U.S. Energy Information Administration. (2016). *International Energy Outlook 2016*. Retrieved from http://www.eia.gov/forecasts/ieo/nat_gas.cfm

CHAPTER 13

KNOWLEDGE CONTENT OF THE MALAYSIAN PHARMACEUTICALS INDUSTRY

CHAPTER 13
Knowledge Content of the Malaysian Pharmaceuticals Industry

13.0 Pharmaceuticals Industry

The pharmaceuticals industry is an important innovation driver for the healthcare system. Driven by increased healthcare needs, there is continuous growth in the demand for pharmaceuticals locally and globally. The total government expenditure on healthcare is expected to continue at equivalent to 4.4% of GDP (EIU, 2014). Much of this is motivated by increasing consumer spending on over-the-counter (OTC) drugs and dietary supplements and herbal and traditional medicines.

The global pharmaceuticals industry is dominated by a small number of pharmaceutical giants. The largest of players, such as Pfizer, AstraZeneca, GlaxoSmithKline, Novartis, Sanofi, Abbott and Roche, exert significant control over the pharmaceuticals industry. These giant players have high capabilities in fundamental R&D and a strong ability to manufacture and market their products on a global scale. Their control over the supply chain is evident and they continuously consolidate through mergers and takeovers. In Malaysia, they remain the incumbents in the originator drugs industry. At the moment, there are no local companies that can match these firms in terms of their financial strength or R&D capability. Consequently, local players focus on the production of generic drugs and nutraceuticals. There is little domestically-led advance in originator drugs as the local focus is on incremental R&D and extraction of active ingredients and improving efficacy of nutrients from natural sources. The main export products for the pharmaceutical industry include antibiotics, hormones, alkaloids, reagents, glycosides, vitamins and vaccines. These goods are primarily exported to Singapore; other principal export markets include Indonesia, United States, Vietnam and Hong Kong.

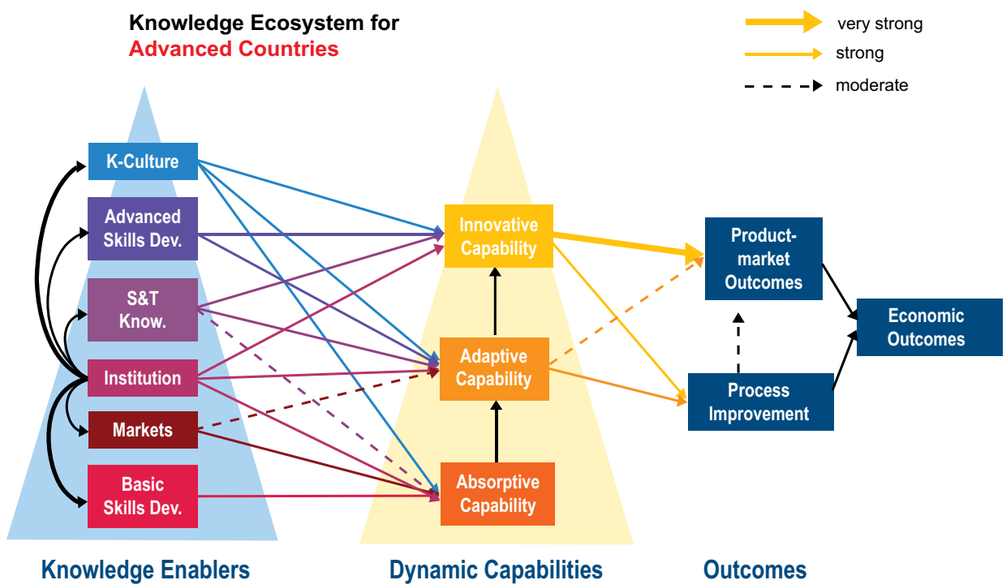
Although Malaysia is an attractive location for global pharmaceutical companies to set up regional offices, their operations remain limited to licensed import, sales and marketing. Ground-breaking research is typically undertaken at the MNCs' headquarters in their home countries, or at research centres that are based in Singapore, Hong Kong and China, with only minor application-led R&D taking place in Malaysia.

One of the main challenges in the generic pharmaceutical industry is the small market value and low profit margins. In addition, the competition in generics is very strong and is price-based, rendering it a challenge for local firms to increase their profitability through value-added propositions. However, some players are starting to realise that product differentiation and niche markets are critical for business continuity. Local manufacturers, especially small enterprises, observe better opportunities in products that cater to specific submarkets, such as nutra-pharmaceuticals, herbal drugs, halal alternatives, novel dosage forms and drugs for tropical diseases. Tropical disease represents a largely overlooked category as MNCs continue to focus on treatments for global, mostly western, diseases. This presents a potential niche for domestic players to make breakthrough discoveries and innovative drugs.

13.1 Knowledge Ecosystem for the Pharmaceuticals Industry in an Advanced Country

The knowledge ecosystem of the pharmaceuticals industry capturing the intricate relationships between knowledge enablers, dynamic capabilities and economic outcomes is shown in Figure 13.1. The figure shows the pharmaceuticals industry in advanced economies to be characterized by richness of interlinks between knowledge enablers, dynamic capabilities and outcomes. The profile for advanced pharmaceuticals country captures original as well as generic drug formulations. Knowledge enablers of the pharmaceuticals industry ecosystem are strong and play a key role in the nurturance and development of strength in dynamic capabilities. Firms in the pharmaceuticals industry of advanced country possess very strong capabilities which they leverage for new drug development.

Figure 13.1: Complex Relationships in the Pharmaceuticals Industry in an Advanced Country



The pharmaceuticals industry in an advanced country is characterized by significant positive contribution to the national economy. To ensure pharmaceutical companies remain globally competitive, a considerable level of resources is invested in skills and competencies for the conduct of leading edge research and manufacture of pharmaceuticals. Through a range of actions and activities of knowledge enablers, firms in the pharmaceuticals industry build absorptive, adaptive and innovative capabilities. The end outcome of firm capabilities is to enhance economic outcomes. The advanced pace setter pharmaceuticals industry is characterized by the following:

- *Policies and Strategies Aligned with Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Pharmaceuticals Industry* – Major global trends taking, such as ageing populations and the associated rise in the incidence of certain types of medical problems, rising healthcare costs, as well as advances in biosciences and genetics, and emergence of IT enabled drug development and administration (e.g. telemedicine) are shaping the practices of the pharmaceuticals industry.

- *Knowledge Institutional System of the Pharmaceuticals Industry* – Institutional players, government bodies, regulatory bodies, industry associations, hospitals and universities play key roles in the development of the industry. Institutions have well established working relationships and act in a highly coordinated manner to challenges. Policy and plans get executed efficiently and progress is monitored over time.

- *Knowledge Capital of the Pharmaceuticals Industry* – The industry is heavily dependent on human capital for its well-being. Medical and health sciences feature prominently but are not the only skills required to succeed in the industry. Manufacturing skills, retail as well as marketing skills are just as important in this complex industry. Skill-needs range from basic to advanced research expertise.

- *Knowledge Approach within the Pharmaceuticals Industry* – Firms in the pharmaceuticals sectors are strongly focused on innovation and create portfolios based on deep understanding of medical and social trends. Firms in the industry are accustomed to invest in R&D and use advanced technology to proactively create high value added products for the future. Pharmaceutical firms are driven from the outset to develop block-bluster drugs that can create fundamentally new revenue streams to sustain them into the future.

- *Knowledge Competency for the Pharmaceuticals Industry* – The industry has a clear map of the skills set needed. Monitoring and tracking of skills is guided through adoption of a systematic framework. Governments in conjunction with medical faculties and health providers play a major role in ensuring the skills needed to sustain the industry are amply abundant.

- *Knowledge Learning & Transfer within the Pharmaceuticals Industry* – Knowledge and innovation networks are formalized to bring together businesses, entrepreneurs, academics and funding agencies to ensure knowledge is shared. Well integrated frameworks are in place to develop key priority areas to create the necessary flows of S&T and R&D. Stakeholders are connected to ensure spill-over benefits are fully reaped by industry.

- *Knowledge Leverage Mechanisms* - Institutions (government agencies, industry association and educational institutions) play a key role establishing platforms and forums of exchange of information and knowledge. Specific platforms and infrastructural facilities are created to ensure that all players in the industry, especially entrepreneurial SMEs, are able to access advances in technology, R&D and other knowledge to improve their operational capability to develop high value-added originator and generic drugs and services.

Example of best practices are provided in the chapter appendix.

13.2 Knowledge Ecosystem of the Malaysian Pharmaceutical Industry

In this section, we provide a description of the knowledge ecosystem for the Malaysian pharmaceuticals industry based on survey data. The survey participants comprise of 14 large firms and 29 small firms, making a total of 43 firms. Of these 11 firms are foreign and 32 local firms. Figure 13.2 shows the state of development of the knowledge enablers. Most enablers exhibit moderate performance. Notable weaknesses are observed in institutions, markets and S&T knowledge.

Figure 13.3 shows the dynamic capability components, process improvement and product development in the Malaysian pharmaceuticals industry vis-à-vis the position of an advanced country. The dynamic capability components, process improvement and product development were measured for large firms, SMEs, local firms and foreign firms. The dynamic capability, process improvement and product development for advanced countries is significantly higher than that of the Malaysian pharmaceuticals industry. Foreign firms established in Malaysia are also observed to have marginally higher dynamic capability and product development

Figure 13.2: Knowledge Enablers for the Malaysian Pharmaceuticals Industry

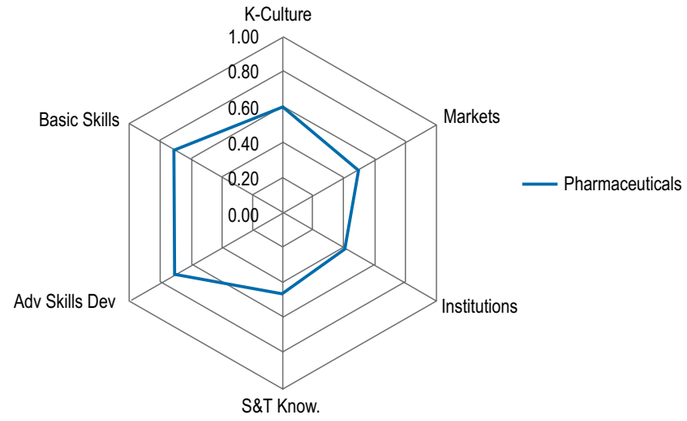
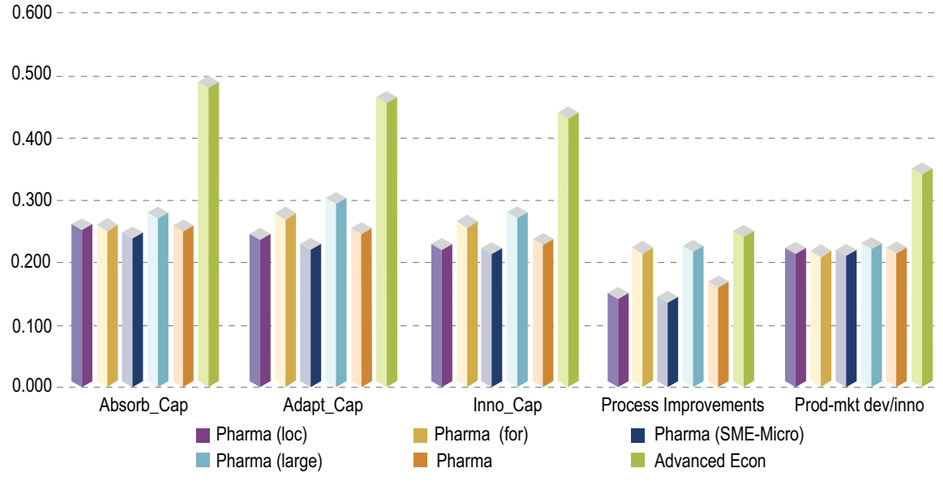


Figure 13.3: State of the Dynamic Capabilities of the Malaysian Pharmaceuticals Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

Figure 13.4: Strategic Posture of the Firms in the Malaysian Pharmaceutical Industry

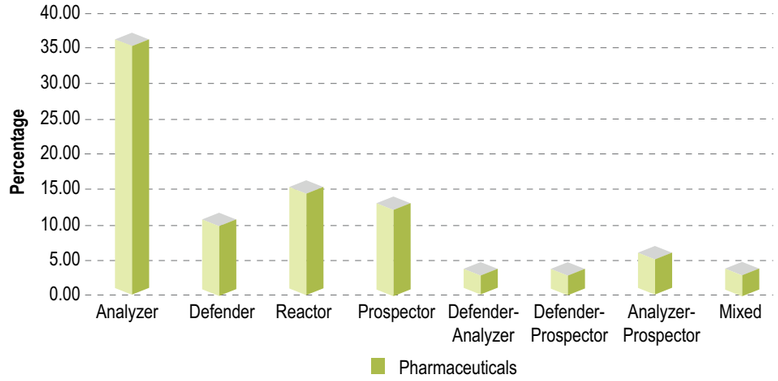
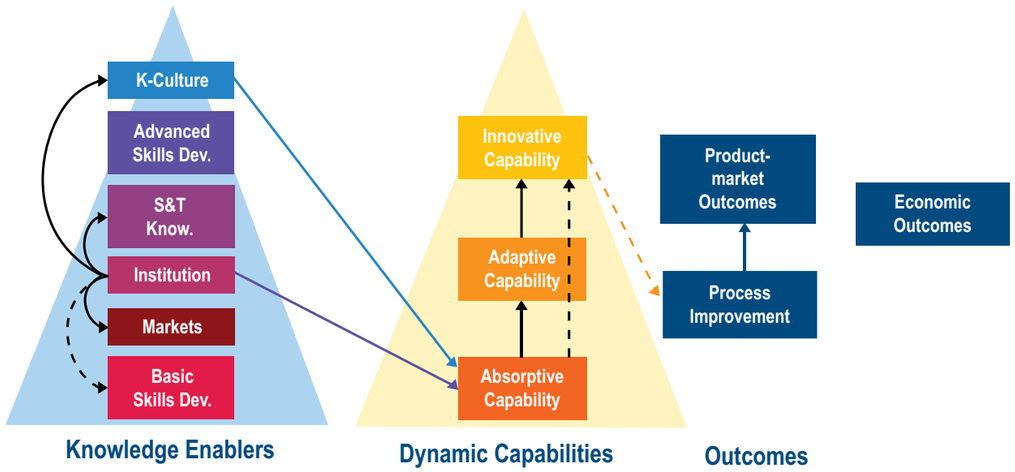


Figure 13.5: Knowledge Ecosystem of the Pharmaceutical Industry



than local firms. Similarly, the same is the case for larger firms relative to SME counterparts.

The strategic postures of firms in the Malaysian pharmaceuticals industry are given in Figure 13.4. The figure shows that a majority of firms are Analyser (37%), followed by the Reactor (16%) and Prospector (13%). Even though the Prospector firm number is small, the ample presence of Analyser and Prospector firms suggests efforts are being made to be innovative.

The knowledge ecosystem for the pharmaceuticals industry is shown in Figure 13.5. Malaysia's pharmaceuticals ecosystem is weak compared to ecosystems that can be observed in advanced countries. This is unsurprising, given that the Malaysian industry is primarily generic and distributive in nature. Institutions in the Malaysian ecosystem are weakly involved and play an indirect role in developing knowledge enablers. Institutions only directly impact development of lower order absorptive capability. This is suggestive of weak institutional arrangement and provision in drugs development.

Knowledge culture plays a role in the positive nurturance of dynamics capabilities but only at the lowest order. Worryingly, the Malaysian pharmaceutical sector appears to have weaknesses in building dynamic capability pathways. Absorptive capability seems only to weakly influence development of higher order absorptive capability. Positively, adaptive capability does influence development of higher order innovative capability.

This absence of strong direct positive effects from advanced skills and S&T knowledge in the development of higher order dynamic capabilities indicates problematic dynamic capability development. Additionally, the only influence from the outcomes is on process improvement. Process improvement appears to be the key driver for Malaysia's pharmaceutical industry. This is unsurprising, given that the focus of the Malaysian sector is on generic drugs.

Overall, the results suggest a weak knowledge ecosystem which in its current state is not ready to make the transition to original drug development. This is not to say that the Malaysian pharmaceutical industry is not making any progress. However, it is current capability that constraints its move into original drug development, given it is one of the most R&D intensive sectors among all industry sectors. It is important to note that a number of bigger firms are making significant efforts to transition toward low to mid-intensity R&D specialty areas. The efforts remain in the early stages but are indicative of positive reflexes for the future. The inability of knowledge enablers in the ecosystem, and in particular institutional enablers to significantly enhance the R&D capacity and innovative ability of the pharmaceutical industry raises concerns over the effectiveness of policy execution in the industry.

13.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Pharmaceuticals Industry

Based on the analysis of the knowledge ecosystem of the pharmaceuticals industry, the key strengths and gaps of the ecosystem are provided in this section of the report.

Key Strengths of the Pharmaceuticals Ecosystem:

- Malaysia has built a sizeable presence in prescription medicines, over the counter (OTC) products, traditional medicines and health supplements.

- The industry ecosystem is constituted by around 300 firms; most local firms are SMEs engaged in the production of generic medicines, traditional medicines and herbal supplements. A number of local firms engage in contract manufacture for foreign MNCS. Large local players (Pharmaniaga, CCM, Hovid, Kotra Pharma) are focused in the production of a range of generics (antibiotics, pain killers, supplements and injectables). Foreign firms (Y.S.P Industries (Taiwan), Sterling Drug (manufacturing arm of GSK, UK), Ranbaxy (India), Xepa-Soul Pattison (Singapore), and SM Pharmaceuticals (India)) also have manufacturing presence in Malaysia. Larger MNCs such as Astra Zeneca, Eli Lilly, Pfizer, Novartis engage in distribution of their branded products through licensed importing.

- Malaysian firms have the capability to produce full range of dosage forms, such as injections, time release medications, soft gelatine preparations, sterile preparations, etc. Additionally, local and foreign firms are already engaged in biopharmaceutical API production, with particular focus on monoclonal antibodies and recombinant proteins. Firms also engage in the provision of FDA (or EMEA) cGMP compliant services.

- Malaysia has a mature regulatory system, under the aegis of the Ministry of Health (MOH). The pharmaceuticals division of MoH monitors quality, efficacy and safety through the National Pharmaceutical Control Bureau (NPCB). Having been set up in 1978, NPCB has in place a structured and comprehensive regulatory system. The Control of Drugs and Cosmetics Regulations 1984 Act led to the establishment of the Drugs Control Authority (DCA) which is charged with issuing licenses to manufactures, importers, wholesalers, and product registrations. NPCB functions as the operation arm of the DCA. Malaysia's regulatory environment also has instituted a robust IP protection.

- Malaysia has managed to secure a number of accreditations and regulatory recognitions (e.g. gained recognition as WHO Collaborating Centre for Regulatory Control of Pharmaceuticals; membership to the Pharmaceutical Inspection Co-operation Scheme (PIC/S); and has been chosen by ASEAN Technical Co-operation among Developing Countries as the regional centre for training programs in quality control. This has allowed Malaysia to be actively involved in GMP, quality assurance programmes and act as a trainer for the region.

- The industry receives significant support from the government in terms of financing for R&D, infrastructure development and capability development (investment for manufacturing, R&D, strategic projects, international procurements and distribution, etc.).

- Malaysia provides a well-developed infrastructure and conducive business environment for firms in the sector to manufacture and distribute pharmaceuticals products in Asia and service international markets. It has world class airports, seaports and telecommunications networks. The infrastructure capability is further enhanced by specialist hubs/parks for healthcare and related activity (Bio-XCell Malaysia; Penang Science Park; Kulim Hi-tech Park; and Enstek- which currently has the largest number of biotechnology and medical firms).

- Malaysia also has additional research infrastructural facilities in the form a Clinical Research Centre made up from 17 centres dispersed across the country. CRC is a one-stop node to access MOH hospitals and clinics for clinical trials. The clinical trial centres provide access to 500+ clinical investigators, and 17million patients with diverse therapeutic needs within Malaysia.

- Large industry players have the resources and capability to undertake R&D to create new products and services, and a number of the top players have used these to good effect in penetrating end-use markets. Both public and private entities can access the centres to conduct clinical trials. Additionally, Malaysia already has three Bioequivalence centres (UM Medical Centre, School of Pharmaceutical Sciences, USM; Inforkenetics Research Centre Sdn Bhd)

Key Gaps Pharmaceuticals Knowledge Ecosystem:

- The health-care NKEA strategic plan incorporates pharmaceuticals within its plan. However, there is a need to keep pace with rapid changes taking place in the industry. Fore-sighting and sign-posting the future directions of the industry, especially the role of emerging science and technology (biotechnology, nano-technology, new manufacturing regimes, materials) requires greater detailing to map out the emerging pharmaceutical and medical regional and global landscape.

- The pharmaceutical industry undergoes heavy regulatory compliance. This means a number of institutions need to interact to ensure quality, efficacy and safety. However, institutional requirements can become burdensome, even with one-stop services if the underlying processes do not align adequately.

- Institutions, such as government agencies and trade associations, are able to ensure compliance but they do not have the level of S&T expertise to drive global best practices and standards. Institutions in effect become control intermediaries rather than a strong enabling intermediaries that help develop the industry.

- Many firms in the pharmaceutical industry fail to successfully and viably commercialize as a consequence of weak resource positions. The problem is exacerbated by the lack of support to penetrate international markets.

- Heavy reliance on licensing drugs and technologies and buying machinery from foreign countries, limits opportunities to innovate. Weaknesses in manufacturing due to dependency on machinery and equipment suppliers pose problems. Moreover, given the strict nature of quality assurance and safety regulation in pharmaceutical manufacturing, an underdeveloped upstream raw material system with high variance in quality and supply adds to the complexity in efficient high quality production. Such variability can severely disrupt the drug manufacturing process.

- Save for a few niche areas, the industry possesses a largely dormant manufacturing and R&D ecosystem, which is unable unless it is considerably strengthened to create market-leading innovations.

- The pharmaceutical industry faces a range of problems that relate to policy implementation, whereby some policies are instituted without the existence of adequate infrastructure/ facilities. This can induce a self-inflicted failure cycle. Attempts by regulators and industry agencies to create enabling environments have ultimately failed because of a lack of dovetailing of the different jigsaw pieces, especially between policy and its implementation. A key reason behind this is agencies continue to work in isolation, and address industry gaps in a fragmented manner.

- With the exception of large players, most firms rely on guidance and support from government agencies for technology, systems and capability development. Government agencies often lack the specialist skills and expertise to provide strong steer to develop dynamic capabilities, especially higher order adaptive and innovative capabilities.

- Firms in the industry do not invest sufficiently in capability development programs to up-skill lower level workers. This constrains their ability to create strong learning at the shop-floor level. Lacking a strong Kaisen approach to skills development, a number of firms in the sector are unable to create sufficient improvements in their manufacturing environments.

- Most large and foreign firms invest in attracting skilled work force, hence their dynamic capability components are higher than smaller and local firms. Key factors impacting local micro-SMEs is their inability to attract talent. Heterogeneous demand for skills within the pharmaceutical ecosystem makes it quite challenging to meet current and future demands for talent. Firms in the pharmaceutical industry have yet to develop the capability to sustainably generate innovation on par with counterparts in advanced countries. In Malaysia, institutions of higher learning focus on training graduates to enter into general practice, such as clinical practice, rather than create research-oriented talent.

- Even though there is ample science, engineering and related area graduates, the quality, especially in their ability to move into research focused roles, needs to be raised. Without a strong base of research talent, pharmaceutical firms continue to struggle to develop innovation outcomes. Despite numerous programmes, Malaysia's 'triple-helix' remains weak, and there is a strong disrupt in the integrated flow of advanced skills needed for adaptive and innovative capabilities.

- Firms, especially SMEs, do not invest adequate resources in advanced skills development, such as developing systems and processes for meeting manufacturing best practice and standards (e.g. quality control), science and technical services (genome sequencing, DNA analysis, bio-informatics, big data analytic etc.), as well as marketing, branding and positioning of products and services.

13.4 Recommendations to Improve the Malaysian Pharmaceuticals Industry Knowledge Ecosystem

The pharmaceutical industry is a key contributor to the Malaysian economy. Strong competition, especially in the form of generics from countries such as India and China, has continued to limit Malaysia's ability to significantly export to regional markets. To ensure strength and viability of the industry, the following recommendations are proposed to strengthen the knowledge ecosystem of the industry.

Recommendation 13.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Pharmaceuticals Industry

Competitiveness of the pharmaceutical industry is predicated upon the industry meeting the global best practices and benchmark standards set by international regulatory bodies. For instance, general standards such as GMP must meet the scrutiny of the FDA. In most advanced countries, where the pharmaceutical sector exists, it tends to be a strong revenue generator. Given the intensity of R&D required to succeed in the sector, substantial resources are channelled to develop an ecosystem that functions optimally. Advanced countries involved in the pharmaceuticals industry often lead in the development and setting of standards.

Malaysia being a key player in the region, with number of accreditation to its credits, should look to see how it can not only meet global standards but become a standard setter.

It is proposed investments be channelled to develop the talent, infrastructure and other support systems to develop capabilities in the pharmaceuticals be able to meet global standards and best practices. These include ensuring government officers and trade associations have a depth of knowledge of the frameworks, regulations and benchmark standards so that they are able to provide assistance to firms to achieve these standards.

Transparent systems and online forums need to be examined to improve their ability to disseminate information and advice on how firms can employ best practices and reach benchmark standards.

Best Practice 13.1: UK Pharmaceutical industry

Recommendation 13.2: Enhance the Knowledge Institutional System of the Pharmaceutical Industry

The government needs to play an orchestrating role to establish sound institutional set-ups to foster close collaboration between key government agencies, industry associations and institutions of learning to formulate clear pathways for the pharmaceutical players to build knowledge based capabilities and gain export market shares regionally and beyond.

It is necessary to establish clear trajectories of development for the pharmaceutical based on specific mapping of starting R&D capabilities and resource positions in order to allow planned transitions. The plan should map a short-term, medium-term and long-term development trajectory based on the portfolio required to transition from volume generics producer to original drug innovator.

The plan should have a clear implementation strategy to meet the established key performance indicators and milestones. Besides catering to large firms, the plan for the industry should ensure SMEs are supported to make the transitions through opening up routes to access resources, support services, technology and networks to increase knowledge content and market reach. A number of steps need consideration:

- Establish an oversight body such as Collaborative Research Excellence in Advanced Medicine (CREAM) to provide direction and systematically enhance the industry-wide innovation value chain by aligning enterprise goals through multi-stakeholder partnerships.

- Greater interaction between the Pharmaceutical Master Plan, National Medicine Plan, the National Healthcare Plan and the National Tourism Plan – Greater synergy will help foster stronger multiplier effect for all four industries.

- Stronger cooperation and collaboration is needed between all relevant ministries to transform the pharmaceutical ecosystem to be efficient. Inter-ministerial co-ordination committee should be set up to periodically review, plan and enable the resolution of red-tape and constraints encountered by Malaysian pharmaceutical companies.

- Stronger promotion of local pharmaceutical products requires input from trade agencies, such as MATRADE. Specialist niche areas such as Halal vaccine to Muslim markets in the Middle East and Africa etc., need to be fully explored given Malaysia's significant lead in the halal industry.

- Stronger facilitation of business friendly environment and higher interaction between key agencies and bodies, such as MoH and halal pharmaceutical standards development. The industry needs to be strongly supported by trade promotion agencies, such as MATRADE. This requires MATRADE to have agents with depth of scientific knowledge to effectively promote pharmaceuticals in new export markets.

Best Practice 13.4: European Medicines Agency

Best Practice 13.6: Developing an integrated approach to medicine development

Recommendation 13.3: Develop the Knowledge Capital of the Pharmaceutical Industry

Interest in science and curiosity to discover are attributes that need to be inculcated at an early stage of education. Pharmaceutical and medical sciences are inherently interesting subjects but strong STEM education must remain a key pillar of public examinations. Comprehensive talent and skills management strategy needs to be formulated to fill gaps in current skills. Future industry skill needs

must be mapped out and actions taken to develop quality and quantity of skills for long term success. A number of actions can help attract individuals into the industry, and include:

- Capable young individuals in colleges and universities should be exposed to potential diverse opportunities and careers in the pharmaceutical industry, from advanced manufacturing to research scientists.

- To ensure full spectrum of skills are appreciated and developed, opportunities for skill and career development should be provided to the workforce working in maintenance and support roles. Workers without formal qualifications should be encouraged to enrol in institutes, colleges and polytechnics to gain professional certification in machinery and manufacturing or other support area. These training programs should be 'hands-on' with industry placement and internship at the core of the course/training curriculum. The training programs should also clearly map a career pathway for students to enrol in higher level technical and academic qualifications.

- The industry needs to work closely with universities on curriculum design and course development. Skills in medical sciences are fundamental in the sectors, but must be complemented by high level of technical skills for efficient manufacture, supply chain, management and end-product marketing.

Best Practice 13.3: UK Pharmaceutical industry-university collaborations in the UK

Best Practice 13.11: Education and skills

Recommendation 13.4: Develop the Knowledge Competency for the Pharmaceutical Industry

The industry should focus on developing core competencies in the drug development and manufacturing. Focus should include emerging medical sciences and technologies. On the manufacturing side, it is necessary to master advanced modes of upstream and downstream manufacturing techniques, such as continuous flow manufacture of drugs. Manufacturing competencies underpin generic drug development success. In addition, if the firms' strategy includes a move into original manufacture or contract manufacture of originator drugs, it is necessary to identify specific areas for scientific focus and complementary this with marketing and regulatory competencies. A number of initiatives can be taken:

- To develop necessary competencies, it is necessary to engage in a range of collaborative arrangements to tap into new knowledge to buttress the existing basin of firm competences. The establishment of highly focussed CoEs (GRIs and universities) along specific scientific thematic is required to ensure supplementary yet critical knowledge is being created by highly skilled and trained groups of researchers.

- Centres of Excellence also need to be established on the manufacturing side of the pharmaceutical industry. Advances, such as those encapsulated in Industry4.0 framework, need to be understood and translated into the operational architecture for pharmaceutical production.

- Skills and competencies that need to be developed beyond medical science are: bioinformatics, engineering, consumer insights, regulatory knowledge, quality assurance, sales and marketing, and ICT platform technologies, legal knowledge of patents, etc. Focus of effort is required to build specific areas of strong capability that can be used to build differentiated market positions. A number of steps are required for this:
  - Identify and invest in niche areas Malaysia can lead at the regional and global level, such as Halal-certified pharmaceuticals, bio-pharmaceuticals, etc.
  - Penetrate markets with specialist pharmaceutical needs, such as halal vaccines and drugs for Muslims, vegetarians and others.
  - Focus on diseases of the tropics to drive drug discovery focus.
  - Develop manufacturing capability (Lean Manufacturing, GMP standards) and capacity to produce generic drugs efficiently.
  - Nurture talent in diverse range and specialist areas needed for the future of the pharmaceuticals industry.

- A number of steps are required to encourage the industry to work closely with universities on leading-edge innovations and skills building:
  - Incentivise universities and research institutes to develop specific areas of expertise, relevant to the needs of the pharmaceutical industry.
  - Develop an incubator for R&D initiatives for advanced medical and scientific breakthroughs that empower third-party researchers through syndicated collaboration programs.

- The CoEs should work closely with educational institutions and training institutes to translate the new discoveries into specific into realizable and implementable programs for firms, large and small.

Best Practice 13.10: HORIZON 2020

Best Practice 13.12: Training, Skills and Competencies

Recommendation 13.5: Facilitate Knowledge Learning & Transfer within the Pharmaceuticals Industry

Associations must take the lead in building innovation capacity and global competitive position by compiling and analysing relevant industry information. Malaysian Pharmaceutical Association of Malaysia or another representative body must drive forward the collective needs of the local industry.

- Financial support in the form of grants (industry-linkage grant), infrastructure support and other development investments need to be provided to universities and GRIs to assist in developing specific research areas.

- Incentives should also be devised to drive knowledge transfer partnerships with industry so that meaningful economic impacts can be generated.

- Firms should be provided incentives to increase their R&D investment and build appropriate pipelines in order to transition to higher value add portfolios.

- Key KPIs of public institutions should be aligned to support the development of local firms, especially micro and SMEs to undertake R&D activities.

- Access to testing and sequencing facilities and specialized expertise needs to be made available to allow firms build dynamic capabilities for enhanced process improvements and new product development.

Best Practice 13.2: UK Pharmaceutical R&D investment and innovation

Best Practice 13.8: Open innovation for collaborative drug development

Recommendation 13.6: Incorporate an Innovative Knowledge Approach within the Pharmaceutical Industry

Foster multi-stakeholders research-related collaborations and partnerships that involve government agencies, private organisations, research centres/oncology care providers, cancer research societies and advocacy organizations, particularly in conducting clinical trials, providing education and training programs, and developing new medicines and therapies. One of the ways to intensify knowledge content in the industry is to adopt the "Fraunhofer" philosophy, which fosters strong partnerships between industry, GRIs, and universities to undertake translational and applied research.

- Key focus areas include:
  - Use of advanced technology (ICT, gene-sequencing methods, nanotechnology and biotechnology).
  - State-of-the art technologies to design and develop manufacturing plants.

- Smart IT technologies to create new business models for healthcare delivery.

- Development of new technology, informatics tools, analytics and knowledge management systems to take advantage of personalized patient centric healthcare systems.

Best Practice 13.5: New approaches to medicine research

Best Practice 13.2: UK Pharmaceutical R&D investment and innovation

Recommendation 13.7: Strengthen Knowledge Leverage within the Pharmaceuticals Industry

Establish a strong industry network with shared collective vision of overall development so as to enable set-up of shared facility or centres to support firms in particular areas of specialized needs within the supply chain. A number of initiatives can be taken, such as:

- ❑ Develop a system and organisation to bridge the gap between academia and industry, in particular as a catalyst for knowledge and technology transfer from universities and research institutions to industries and firms.

- ❑ Tap in knowledge repositories of key bodies and drugs regulatory agencies to establish clear protocols for success and markets.

- ❑ Strengthen infrastructure, such as CRM for clinical trials and science parks to create stronger knowledge flows between the networks.

- ❑ Incentivise universities, colleges, polytechnics and training institutes to be integral parts of CoE, science parks and knowledge centres across the country.

- ❑ Put in place policies to encourage foreign and local firms to use locally manufactured pharmaceutical products. This will provide a much needed boost to the industry and the local economy.

- ❑ Utilize programs, such as GIFTS, to attract MNCs that are willing to partner with local firms.

- ❑ Create more joint ventures and partnerships between foreign and local companies.

- ❑ Adopt or intensify use of Industry4.0 to improve greater efficiency, productivity, interaction and innovation.

Best Practice 13.7: CBI Collaborative Research to tackle grand challenges in medicines development

Best Practice 13.9: The Innovative Medicines Initiative

13.5 Conclusion

This chapter provided valuable information on the state of the knowledge ecosystem for the Malaysian pharmaceuticals industry. The analysis highlighted some of the key strengths and gaps in the knowledge ecosystem. In particular, the study identified the key knowledge enablers that are strong and have enabled the industry to be a major player. The empirical analysis also identified some of the weaker links in the ecosystem and key reasons for these gaps in the ecosystem. In this chapter, we also discussed key policies and strategies to strengthen the knowledge enablers so as to ensure that the dynamic capability components of the industry are raised to higher levels.

Appendix for Chapter 13

Best Practice 13.1: UK Pharmaceutical Industry

The UK is traditionally a base for high quality pharmaceutical manufacturing, particularly of innovative medicinal products and delivery systems. Access to skills and knowledge, a robust legal system for the protection of Intellectual Property (IP), and world class manufacturing capability have contributed to making the UK a centre for discovery and development of new medicinal products.

The pharmaceutical industry delivers a significant contribution to the UK economy and the population as a whole. It remains a jewel in the UK's scientific and industrial crown.

- The pharmaceutical industry contributes more to the UK economy than would be possible if other industrial sectors used the same resources. In other words, the people and capital employed in the pharmaceutical industry earn more income for the UK than if they were in any other sector of the economy.

- All leading pharmaceutical corporations operating in the global market have a presence in the UK.

- The existence of multiple bodies who work together in a highly coordinated manner define the pharmaceutical ecosystem of the UK.

Best Practice 13.2: UK Pharmaceutical R&D Investment and Innovation

Research and development (R&D) is core to the pharmaceutical industry, which invests more than any other industrial sector in the UK, with up to approximately £11.2 million spent every day.

More than half of the entire research expenditure by the pharmaceutical industry in the UK is funded and carried out by the industry itself. Following the vast investment in R&D, the research-based pharmaceutical industry is one of Britain's leading high-technology industrial employers.

Knowledge generated by R&D can flow from one organisation to other companies in the same sector, but in many cases cutting-edge knowledge flows to other sectors, as well as public and charitable organisations. According to a study by the Office of Health Economics (OHE), this spill-over effect generated by pharmaceutical R&D is estimated to be more than double the return that is captured by the company actually making the pharmaceutical R&D investment.

Best Practice 13.3: UK Pharmaceutical Industry-University Collaborations in the UK

Data on the support pharmaceuticals companies have given to universities and students since 2003 suggest that more than 600 PhDs, 300 Post-Doctorates and are 400 undergraduates are supported on average per annum.

The data above is from the R&D side only; collaborations and placements within manufacturing and commercial parts of companies are not included.

Best Practice 13.4: European Medicines Agency

Britain hosts the headquarters of the European Medicines Agency (EMA), the European Union's body for the licensing of new medicines, and has played a leading role in developing European regulatory activities. In order to attract EMA, Britain needs to ensure it is an appealing destination for the location of EMA.

Britain does this through a range of initiatives such as:

i. UK Clinical Research Collaboration

   The UK Clinical Research Collaboration (www.ukcrc.org) was established in 2004. It is a partnership between industry, the Government, professional bodies, the health service and research funding medical charities that support clinical research in the UK. This initiative is the consequence of a recognition of the need to strengthen the funding, co-ordination and execution of both academic and clinical research to ensure that Britain remains an attractive venue for medicinal research.

ii. Clinical trials

Clinical trials have always been a vital part of the medicine development process, as they provide data on the best ways of treating diseases. Britain has made a significant contribution to this, and continues to do so. With a high concentration of research-based pharmaceutical and biotechnology companies, leading centres of academic medicine, and a long history of pioneering research, Britain is the leading venue in Europe for running the complex and often multinational studies needed to develop new medicines.

Best Practice 13.5: New Approaches to Medicine Research

The conventional pathway of drug development has been successful for many years and is still a viable model/ framework to develop medicines for certain diseases. However, it is now generally accepted that the hugely increasing cost of drug development has not been reflected in a similarly large increase in the number of new medicines.

New techniques and approaches

Developing medicines in increasingly complicated therapeutic areas, requires new approaches are be needed, such as:

- The identification of reliable biomarkers to identify patients who are most likely to respond well to a particular treatment.
- Developing medicines for a smaller, more targeted population and launching medicines early in development, with a comprehensive post marketing safety surveillance programme, as called for in the US NEWDIGS initiative from the Massachusetts Institute of Technology.
- Where there is a high unmet medical need, a facility should be set up to make key treatments available to patients before they are formally launched. The UK has been making good progress in this area.
- Using 'adaptive trial designs' where a trial is modified over time, according to modelling performed using data gathered from the trial as it progresses.

Best Practice 13.6: Developing an Integrated Approach to Medicine Development

In the UK, the development and implementation of an integrated stakeholder strategy in personalised medicine brings benefits to patients, but also prescribers, payers, and regulators; it also improves the efficiency and productivity of developing new treatments, and enhance UK competitiveness and attractiveness for drug and diagnostic research and development (R&D).

On this front, the ABPI has been intensively engaged on the development of an integrated personalised medicine approach over an extended period, working closely with a range of partners such as:

- The diagnostics sector
- Research funders
- Regulators
- Healthcare providers and policymakers
- Health informatics programmes
- Health economists

Through ABPI's work with the Medical Research Council good progress has been made on the research front, with non-competitive collaborative partnerships established between pharmaceutical companies, universities and NHS centres, in areas of high disease burden such as respiratory inflammatory disease and joint inflammatory disease, and with Cancer Research UK (CRUK) in cancer research. In recent times, a £50 million initiative in Stratified Medicine was launched by Innovate UK (formerly the Technology Strategy Board), to realize the development of personalised healthcare.

Best Practice 13.7: CBI Collaborative Research to Tackle Grand Challenges in Medicines Development

CBI's mission is to improve global health by overcoming obstacles to the development and implementation of biomedical innovation. CBI provides a safe and transparent environment for collaborative research among industry, academia, and government, and draws on the expertise of the Massachusetts Institute of Technology's (MIT) Schools of Engineering, Science, and Management, as well as the Harvard-MIT Division of Health Sciences and Technology (HST).

CBI was established in 2005. In 2008, the Centre merged with MIT's Program on the Pharmaceutical Industry (POPI). POPI was founded in 1991 with a major grant from the Alfred P. Sloan Foundation to promote research and educational activities on issues related to competitiveness, performance and productivity in the pharmaceutical field.

CBI addresses profound challenges in the global biomedical industry by developing, testing, and disseminating new knowledge and tools designed for real world application through the following programs: the Biomanufacturing Program (BioMAN), the Consortium on Adventitious Agents in Biomanufacturing (CAACB), and New Drug Development Paradigms (NEWDIGS).

1. MIT NEWDIGS

MIT NEW Drug Development ParadIGmS (NEWDIGS) is an international "think and do tank" dedicated to helping biomedical innovation benefit all healthcare stakeholders faster and reliably. NEWDIGS designs, evaluates, and initiates advancements that are too complex and cross-cutting to be addressed by a single organization or market sector. Its members include global leaders in research, development, insurance, regulation, and patient advocacy. For more information, visit http://newdigs.mit.edu.

2. MIT CBI BioMAN

The objective of the MIT CBI BioManufacturing Program is to develop new knowledge, science, technologies and strategies that advance the manufacture and global delivery of high quality biopharmaceuticals.

To address emerging Biomanufacturing needs, **BioMAN** activities are focused on:

- Advanced product and process analysis for optimized quality manufacturing
- Flexible modular platforms for biotherapeutic production and delivery
- Assessment and mitigation of risk in biopharmaceutical production
- Global delivery of biopharmaceuticals
- Regulatory science

BioMan fosters a collaborative research environment that brings together thought leaders from industry, the government/FDA and academia.

http://cbi.mit.edu/research-overview/bioman/

http://cbi.mit.edu/research-overview/bioman/bioman-activities/bioman-activities-research-area-1/

http://cbi.mit.edu/research-overview/bioman/bioman-activities/bioman-activities-research-area-2/

http://cbi.mit.edu/research-overview/bioman/bioman-activities/bioman-activities-research-area-3/

http://cbi.mit.edu/research-overview/bioman/bioman-activities/bioman-activities-research-area-4/

http://cbi.mit.edu/research-overview/bioman/bioman-activities/bioman-activities-research-area-5/

http://cbi.mit.edu/research-overview/bioman/bioman-activities/

Best Practice 13.8: Open Innovation for Collaborative Drug Development

The best brains can be found across different sectors and increased collaboration between industry, academia, the NHS and regulators is fostered in order to achieve a reduction in the time it takes to develop new medicines for patients. This takes place in pre-competitive or non-competitive research, for example in areas such as predictive toxicology, drug target identification and validation and the identification of novel biomarkers. Some good examples are:

- *The Stem Cells for Safer Medicines* public-private partnership, which specialises in the identification of stem cell derived cell lines for predictive toxicology – www.sc4sm.org
- *The Innovative Medicines Initiative* – www.imi.europa.eu

- *The MRC-ABPI immunology and inflammation initiative* – www.mrc.ac.uk

- *The Therapeutic Capability Clusters* as proposed in the Office of Life Sciences 2009 *Life Sciences Blueprint*

http://www.imi.europa.eu/

Best Practice 13.9: The Innovative Medicines Initiative

The Innovative Medicines Initiative (IMI) is Europe's largest public-private initiative aiming to speed up the development of better and safer medicines for patients.

The Innovative Medicines Initiative (IMI) aims to improve health by speeding up the development of, and patient access to, innovative medicines, particularly in areas where there is an unmet medical or social need.

It does this by facilitating collaboration between the key players involved in healthcare research, including universities, the pharmaceutical and other industries, small and medium-sized enterprises (SMEs), patient organisations, and medicines regulators.

IMI is a partnership between the European Union (represented by the European Commission) and the European pharmaceutical industry (represented by EFPIA, the European Federation of Pharmaceutical Industries and Associations).

IMI supports collaborative research projects and builds networks of industrial and academic experts in order to boost pharmaceutical innovation in Europe. IMI is the world's biggest public-private partnership (PPP) in the life sciences. Through the IMI 2 programme, it has a €3.3 billion budget for the period 2014-2024. Of this:

- **€1.638 billio**n (half the budget) comes from Horizon 2020, the EU's framework programme for research and innovation;

- **€1.425 billion** is committed to the programme by **EFPIA companies**;

- **up to €213 million** can be committed by other life science industries or organisations that decide to contribute to IMI 2 as **members or Associated Partners** in individual projects.

EFPIA companies and Associated Partners do not receive any EU funding, but contribute to the projects 'in kind', for example by contributing their researchers' time or providing access to research facilities or resources.

Best Practice 13.10: HORIZON 2020

Horizon 2020 is the biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over 7 years (2014 to 2020) – in addition to the private investment that this money will attract. It promises more breakthroughs, discoveries and world-firsts by taking great ideas from the lab to the market.

Horizon 2020 is the financial instrument implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness.

Seen as a means to drive economic growth and create jobs, Horizon 2020 has the political backing of Europe's leaders and the Members of the European Parliament. The European Parliament consensus is that research is an investment for Europe's future, so they put it at the heart of the EU's blueprint for smart, sustainable and inclusive growth and jobs.

By coupling research and innovation, Horizon 2020 places emphasis on excellent science, industrial leadership and tackling societal challenges. The goal is to ensure Europe produces world-class science, removes barriers to innovation and makes it easier for the public and private sectors to work together in delivering innovation.

Horizon 2020 is open to everyone, with a simple structure that reduces red tape and time so participants can focus on what is really important. This approach makes sure new projects get off the ground quickly – and achieve results more quickly.

Best Practice 13.11: Education and skills

The ABPI provides a forum for member companies that are involved in academic interactions and educational activities. Here they meet and share ideas and experiences, and establish and maintain links with academia, relevant Government departments, Research Councils and other organisations who provide higher education and skills training.

The main aim of these activities is to create an environment to support and develop the science, technology, engineering and maths (STEM) skills base in the UK. This skills base will develop the personnel required by companies that produce medicines.

The country, and biopharmaceutical industry, needs a continuous supply of high quality scientists, engineers, doctors and many other specialists, to meet the demands of an evolving and more technology-led industry.

A Science Industry Partnership (SIP) was created in 2014 to take action to address the needs of employers in the life sciences. The SIP has attracted a £52 million investment (with contributions from Government and employers) to develop new and emerging science talent, creating more than 7,800 education and skills opportunities over a two-year period.

The SIP structure is an employer-led and managed arrangement for engaging in skills development and delivery. The SIP Board provides a high level strategic conversation, setting the context for decisions about skills needs.

ABPI support for schools and careers

ABPI has developed an interactive Resources for Schools website, with curriculum-linked science content for students, teachers and parents. The ABPI Careers website gives students, parents, careers advisors and graduates an overview of the industry and the kinds of careers that are available within companies that produce medicines.

This site provides teachers and students with high quality, free, curriculum related, interactive resources containing animations and diagrams which can be downloaded. All resources link science topics covered in school to the world outside and, particularly, to the treatment of disease.

http://www.abpischools.org.uk/

http://careers.abpi.org.uk/Pages/default.aspx

Best Practice 13.12: Training, Skills and Competencies

IMI is involved in an extensive range of skills and competency building programs. One example is the EMTRAIN project.

***EMTRAIN* - European Medicines Research Training Network**

The European Medicines Research Training Network (EMTRAIN) supports a pan-European platform for education and training, covering the entire life-cycle of medicines, from basic research, clinical tests and market authorisation to follow-up research of drugs already on the market.

- The consortium provides a mechanism to ensure that industry and academia cooperate on courses that can be rapidly designed and implemented, in order to enable a faster implementation of new scientific and technological developments in academic teaching.

- Through harmonisation and accreditation of Master level, PhD programmes and continuous education programmes, EMTRAIN aims to improve the mobility across disciplines and national borders, as well as between academia, industry and regulatory authorities.

- The consortium includes six established pan-European biomedical research infrastructures that cover a broad spectrum of competencies, from structural biology, bioinformatics, animal models, biobanks, translational research and clinical research.

Other projects

http://www.imi.europa.eu/content/emtrain

http://www.imi.europa.eu/content/ongoing-projects?training=118

CHAPTER 14

KNOWLEDGE CONTENT OF THE MALAYSIAN FOOD PROCESSING INDUSTRY

CHAPTER 14
Knowledge Content of the Malaysian Food Processing Industry

14.0 Introduction

The food processing industry is primarily made up of manufacturers of food supplies (semi-finished) and finished food products. A recent report by Research and Markets (a Dublin-based market research firm) revealed that the global food market is expected to bring in a revenue sum of $3.03 trillion by 2020, registering a compound annual growth rate (CAGR) of 4.5 percent from 2015 to 2020 (Hartman, 2015). Geographically, North America is the largest market, followed by Europe, APAC and LAMEA (Hartman, 2015). Rising demand from emerging economies contributed significantly to the growth of the packaged food market. In particular, growing awareness and increasing adoption of packaged foods is expected to make the Asia-Pacific region the fastest growing market area.

While the trends of the global industry provide a positive outlook, the industry is dominated and controlled by a relatively small number of companies. The top 10 most influential food and beverage companies that control the world's food are Associated British Foods (ABF), Coca-Cola, DANONE, General Mills, Kellogg, Mars, Mondelez International (previously Kraft Foods), Nestlé, PepsiCo and Unilever (Oxfarm, 26 February 2013).

Globally, there is a rising expectation from consumers on food quality, safety and variety. It is no longer feasible for food manufacturers to merely focus on the affordability of food. Recent interviews conducted by Food Processing with food and beverage companies in Europe and North America reveal that companies have started to focus on macro-ideas over incremental product development. Accordingly, there is "a rise in democratic approaches to innovation as well as out-of-sector inspiration and consumer-centricity" in the industry (Fusaro, 12 Sept 2016).

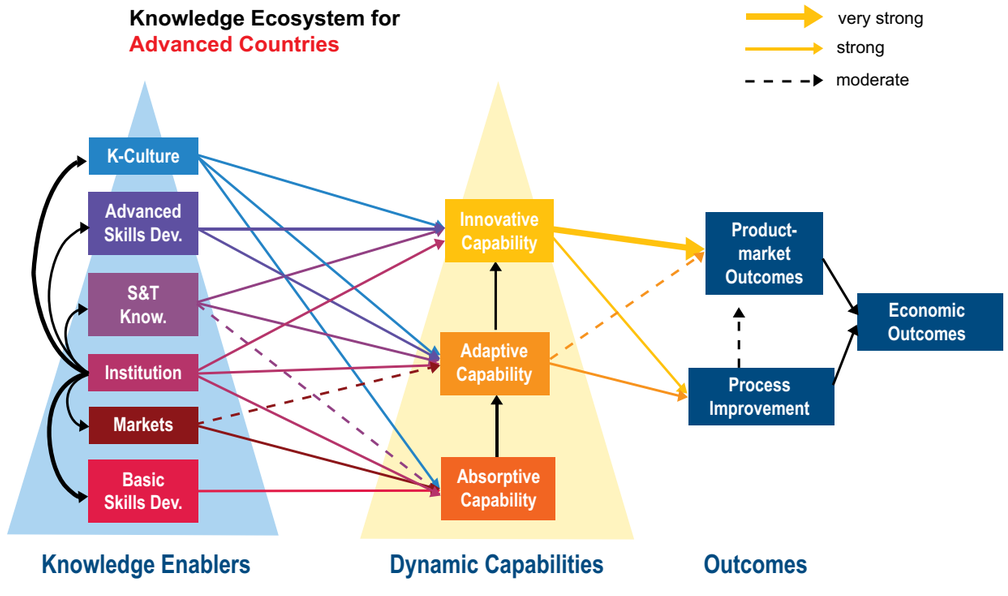
The chapter is organized as follows: In Section 14.1 a description of knowledge ecosystem of food processing sector in an advanced economy is provided. In Section 14.2, we provide a description of the knowledge ecosystem for the Malaysian food processing industry. In Section 14.3 the essay discusses the key strengths and gaps in the Malaysian food processing knowledge ecosystem. In Section 14.4, key recommendations to improve the knowledge ecosystem of the Malaysian food processing industry are furnished before concluding in Section 14.5.

14.1 Knowledge Ecosystem in an Advanced Food Processing Economy

Figure 14.1 demonstrates the relationship between knowledge enablers, dynamic capabilities and economic outcomes for advanced countries. As shown in the figure, knowledge enablers for all three components of the dynamic capability are all very strong in the advanced food processing economy. Institutions (government agencies, trade associations and universities) in advanced countries play a key role in driving enablers to nurture dynamic capability components, as well as directly influencing dynamic capability components. Key components of the knowledge ecosystem for food processing sector in advanced countries are discussed next.

The knowledge ecosystem for the food processing industry in advanced countries exhibits high level of development and positive contribution to the economy. Knowledge enablers for food processing all contribute to absorptive, adoptive and innovative

Figure 14.1: Complex Relationships in the Food Processing Industry in an Advanced Country



capabilities, and thereby drive process improvement and new product development. All these contribute to economic outcomes collectively. In other words, continued investments in knowledge enablers helps build dynamic capabilities that sustain the development of food processing industry. The following initiatives are undertaken by food processing industries in advanced countries:

- Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Food Processing Industry. Emerging issues and standards of practice feature strongly in the food industry. Ethical and sustainable sourcing and supply chain carbon footprint, organic and natural foods, health and food safety standards all feature as important determinants of trade in food industry. There exist a wide variety of bodies that stipulate and govern these standards of practice. *Best Practice:* ***Case-Study 14.1 – Food and Drugs Agency (FDA), USA.***

- Knowledge Institutional System of the Food Processing Industry – Government works in partnership with key stakeholders to develop an institutional set-up for the industry that drives and strengthens the capability of industry players to compete internationally. *Best Practice:* ***Case-Study 14.2 – The Australian Research Council Training Centre for Food Processing Industry in the 21st Century at the University of Sydney.***

- Innovative Knowledge Approach within the Food Processing Industry – The food industry capitalizes on advanced technology to foster seamless integration of all production processes within the food processing value chain from ensuring translation of R&D outcomes, improving operational efficiencies, and developing new products. *Best practice:* ***Case-Study 14.6 - The US Cold Chain System.***

- Knowledge Capital of the Food Processing Industry – The workforce is provided with a wide range of training programs and courses from non-award certification training programs to more formal qualifications such as diploma, undergraduate, postgraduate and research programs. This is to ensure that the workforce is well equipped to deal with the industry's current and future needs. *Best Practice:* ***Case-Study 14.3 - Institute of Food Technologists.***

- Knowledge Competency for the Food Processing Industry –The skill set needed by the industry is carefully planned. The industry has a systematic framework and tracks the changing landscape of the industry, reviewing and upgrading competencies accordingly. *Best Practice:* ***Case-Study 14.4 - The Canadian Food Processing Institute, Food Processing Human Resources Council (FPHRC).***

- Knowledge Learning & Transfer within the Food Processing Industry – A sound integrated framework is in place in most advanced countries to develop key priority areas through S&T and R&D and ensures the spill-over benefits are translated for industry. *Best Practice:* ***Case-Study 14.5 – The Australian Research Council Training Centre for Food Processing Industry in the 21st Century at the University of Sydney.***

- Knowledge Leverage within the Food Processing Industry – Institutions (government agencies, industry association and educational institutions) play a key role in establishing platforms and forums to facilitate the exchange of information and knowledge among industry players. *Best practice:* ***Case-Study 14.7 - Cornell University, College of Agriculture and Life Sciences, Northeast Center for Food Entrepreneurship.***

14.2 Knowledge Ecosystem of the Malaysian Food Processing Industry

In this section, we provide a brief description of the knowledge ecosystem for the Malaysian food processing industry based on survey data. The survey consists of 207 firms in total. In terms of size, 45 are large firms and 162 are small firms. In terms of ownership, 23 are foreign firms and 184 are local firms. Figure 14.2 show the state of development of the knowledge enablers. All enablers are performing at the moderate level, except for institutions (score below 0.4).

Figure 14.3 show the dynamic capability components, process improvement and product development in the Malaysian food processing and that of a comparable industry from an advanced country. The dynamic capability components, process improvement and product development were measured for large firms, SMEs, local firms and foreign firms. The dynamic capability, process improvement and product development for advanced countries were found to be significantly higher than that of the Malaysian food processing industry. Within the Malaysian food processing industry, foreign firms were found to have higher dynamic capability than local firms.

Figure 14.2: Knowledge Enablers for the Malaysian Food Processing Industry

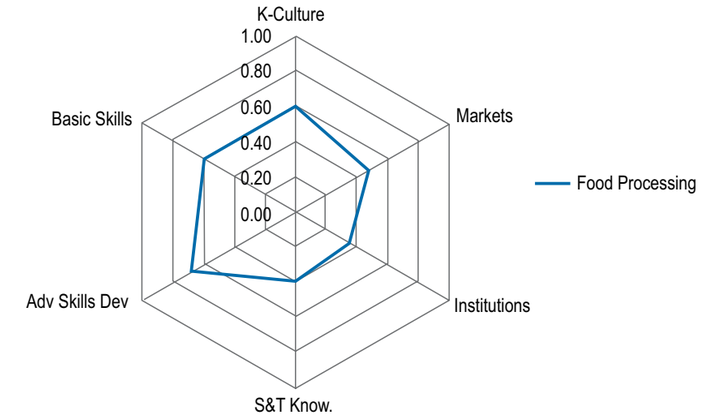
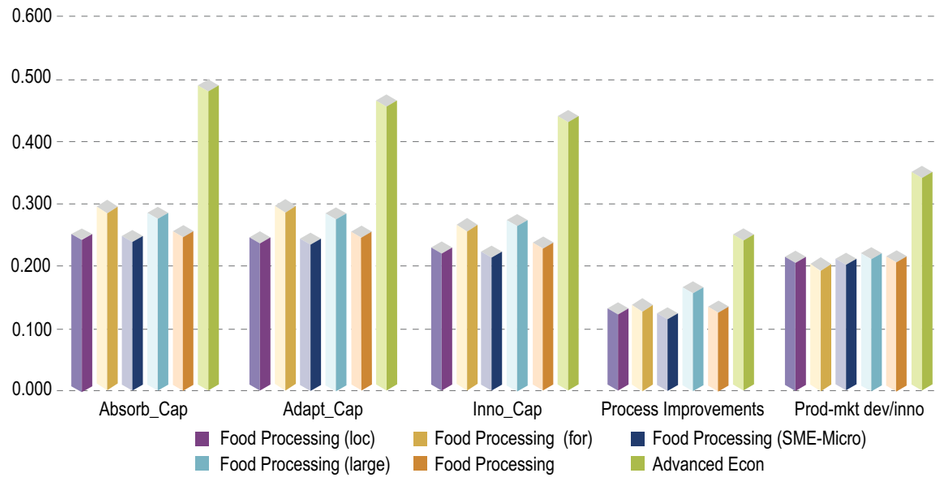


Figure 14.3: State of the Dynamic Capabilities of the Malaysian Food Processing Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

Surprisingly, foreign firms score only marginally higher than local firms in terms of process improvements and even scored lower than local firms in product development. Larger firms have higher process improvement than SMEs.

The strategic postures of firms in the Malaysian food processing industry are given in Figure 14.4. The figure shows that a majority of firms are Analyzer firms (about 40%), followed by Defender firms at over 15%, and Defender-Analyzer (11%) firms. Only about 6% of the firms in the food processing industry are Prospector firms. This suggests only a small proportion of firms in the food processing industry are actively involved in innovation activity.

The knowledge ecosystem for the food processing industry is shown in Figure 14.5. Results show that basic skills development and market intelligence of food manufacturers contribute to adaptive capability, but not absorptive capability (like most advanced countries counterparts). Interestingly, institutions contribute to innovative capability significantly among Malaysian food manufacturers. S&T knowledge has no impact on the dynamic capabilities of food manufacturers in Malaysia. Furthermore, advanced skills development does not contribute in building adaptive capability but it does contribute to absorptive capability.

Figure 14.4: Strategic Posture of the Firms in the Malaysian Food Processing Industry

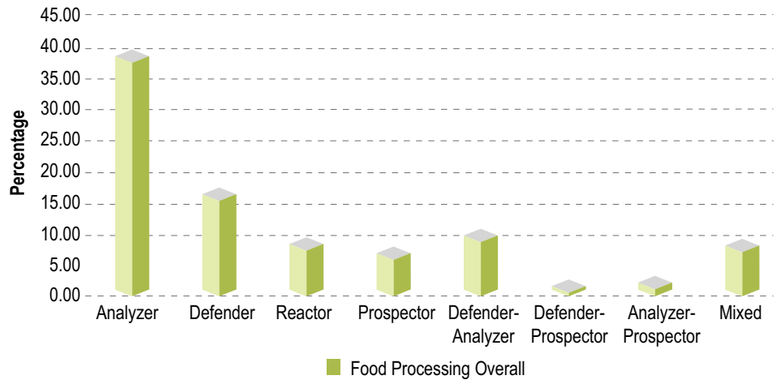


Figure 14.5: Knowledge Ecosystem of the Food Processing Industry

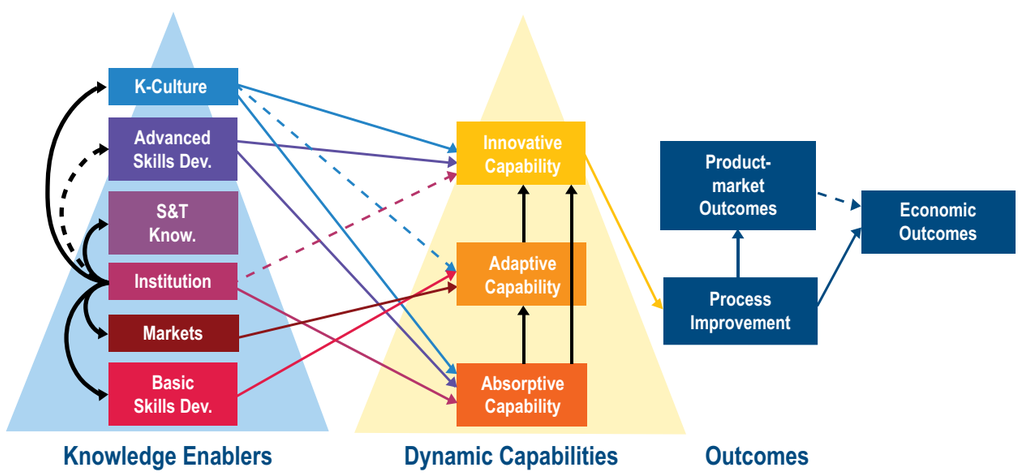
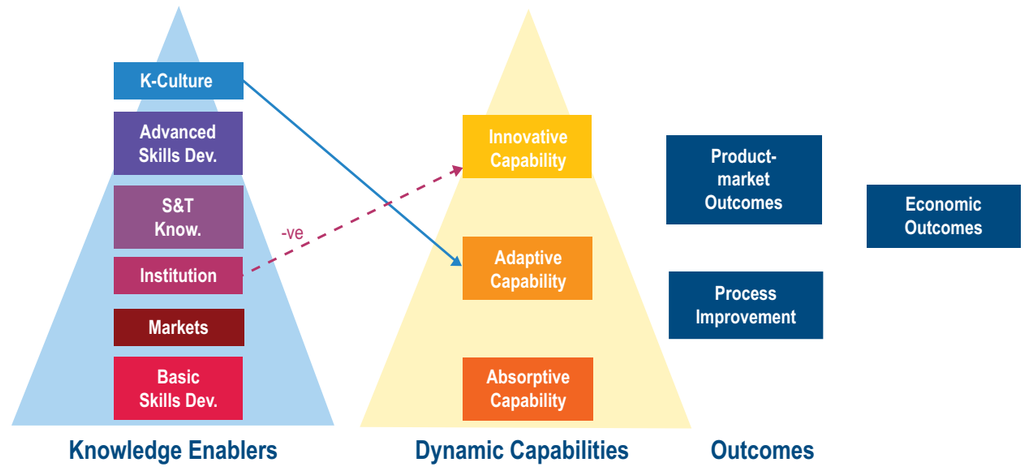


Figure 14.6: Knowledge Ecosystem for Food Processing Large vs Food Processing Micro-SME



Knowledge culture in food manufacturers contributes to all three forms of dynamic capabilities building. Its impact on adaptive capability is particularly significant. In addition to building dynamic capabilities in a sequential manner, there is a direct impact from absorptive capability in building innovative capability among Malaysian food manufacturers. Subsequently, innovative capability only leads to process improvement but not product-market outcomes among food manufacturers. Also, adaptive capability does not lead to process improvement or product-market outcomes.

The food processing ecosystem is compared for large and micro-SME firms and the results of the multi-group analysis are presented in Figure 14.6. The results show that impact of institutions on innovative capability building is more significant among small food manufacturers as compared to large firms. This confirms the important role of certain government agencies (such as SIRIM, Matrade, etc) in supporting the innovative capability of small food manufacturers, particularly in branding and marketing capability. In most cases, small firms cannot afford to build in-house innovative related capability, such as testing labs, a marketing team, etc.

Institutions also contribute significantly to advanced skills development of food manufacturers. It is often too costly for food manufacturers to engage in building advanced skills independently. Instead, they rely on various institutions for advanced skills development. For example, individual food manufacturers refer to Matrade, Halal Industry Development Corporation and related industry associations for advanced knowledge and information if they are interested to venture into the Halal Food sector.

The impact of knowledge culture in building adaptive capability is significantly higher among large food manufacturer as compared to smaller firms. Large firms spend more resources to learn new knowledge and adapt and implement in the firm. In small firms, most employees' hands are tied with meeting demands of daily operations. They may spare little time or resources to facilitate adaptive capability building.

14.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Food Processing Industry

Based on the analysis of the knowledge ecosystem of the food processing industry, the key strengths and gaps of the ecosystem are provided in this section of the report:

Key Strengths of the Food Processing Ecosystem:

Growth of agriculture industry, especially crop-based industry, opens up growth prospects for the food processing industry.

- Being a Muslim majority country, the Halal food industry is the largest and most important segment in Malaysia's food processing industry. Malaysia's strong position as a pace-setter of halal standards and depth of knowledge presents a large opportunity that it can potentially capitalize on to build a strong niche position in the halal food sector.

- Malaysian halal produce is globally accepted and recognized. Malaysia halal food manufacturing sector is at the vanguard of Halal standards and certification.

Key Gaps of the Food Processing Ecosystem:

- The majority of food manufacturers are labour-intensive. Workers with only low basic skills are a key constraint if food manufacturers wish to implement good manufacturing practices, such as standardized operations and implementing advanced food manufacturing system.

Key Gaps of the Food Processing Ecosystem:

- The majority of the food manufacturers are SMEs, who have insufficient market intelligence about key trends that are likely to shape the future of the food processing industry. With limited resources, most food manufacturers do not systematically collect and analyse data about markets. Oftentimes, decisions are made based on ad hoc and random searches for information on the internet, as well as sporadic information provided by customers and/or suppliers.

- Institutions, especially vocational schools and higher education institutions, fail to adequately meet the demand of human resources requirement of food processing industry (food safety, food science, etc). Even though Malaysia has a number of hospitability and culinary schools, their impact into food processing industry remains limited.

- Food manufacturers continue to rely heavily on low-end technology. Without S&T knowledge and advanced food technologies, Malaysian food manufacturers have difficulty to scale and tap into growing export markets.

- Food manufacturers invest insufficiently in advanced food manufacturing knowledge (such as food science, advanced manufacturing or quality control procedures). They emphasize machinery but such investment alone only leads to a low level of dynamic capabilities building. Without internalizing new skills, food manufacturers are not able to take full advantage of their investment in advanced skills development. This is particularly important among food manufacturers who wish to take advantage of the growing halal food market. Information and knowledge about requirements of halal standards needs to be fully internalized and dovetailed with advanced food science, (e.g. novel enzyme functional foods) to create food innovation.

- Despite new knowledge and information, food manufacturers fail to adopt, utilize and implement new knowledge in the organization due to weak culture of sharing and systematic approach to synthesis and use of knowledge.

14.4 Recommendations to Improve the Malaysian Food Processing Knowledge Ecosystem

The food processing industry has the potential to grow and become a major contributor to the Malaysia's economy. To ensure viability and competitiveness of the Malaysian food processing industry, the following recommendations are proposed to strengthen the knowledge ecosystem and knowledge content of the industry.

Recommendation 14.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Food Processing Industry

Malaysian food processing industry has to respond to increasing demand for safe, healthy and quality food in the global market. Even with small scale operations, companies must adhere to standards and best practices voluntarily is the key to ensure productivity and efficiency. In addition to Halal standards, Malaysian food manufacturers should also benchmark best practices pertaining to manufacturing practices and quality management such as Food Current Good Manufacturing Practices (CGMPs), Hazard Analysis and Critical Control Points (HACCP) procedures, Quality Management Best Practices for Food and Beverage Manufacturers, etc.

- ❑ Develop a holistic Food Processing Ecosystem such that it involves the entire supply chain (upstream and downstream) of the industry to ensure continuous support in terms of resources, sharing of best practices, talents and skills.

- ❑ Encourage leading MNCs, such as Nestle, to take the lead in developing key food manufacturing practices and standards that may serve as guides for SMEs to enhance their manufacturing capabilities. SMEs must also make concerted efforts to learn from the MNCs.

- ❑ Halal Industry Development Corporation constantly monitoring and enhancing standards and best practices developed specifically for food processing to ensure that the Malaysian Halal Standards match the global food safety and hygiene standard.

Best Practice: ***Case-Study 14.1 – Food and Drugs Agency (FDA), USA.***

Recommendation 14.2: Enhance the Knowledge Institutional System of the Food Processing Industry

All relevant stakeholders, such as Ministry of International Trade and Industry, Ministry of Agriculture and Agro-based Industry, Halal Industry Development Council, Industry Association, individual manufacturers, higher education institutions to play a part in ensuring that the food processing knowledge ecosystem is well established and operationalized effectively for the continued development of the industry.

- ❑ Government agencies to study and identify synergies between food processing and agriculture industries so that local food processing players have ready access to local high quality raw materials.

- Establish a strong industry network and partnership in which learning and capability building can take place.

- Engage with the supply chain of large local and global retailers, such as MYDIN, AEON,TESCO, to develop relationships based on consistency, reliability of delivery and quality of food.

Best Practice: ***Case-Study 14.2 – The Australian Research Council Training Centre for Food Processing Industry in the 21st Century at the University of Sydney.***

Recommendation 14.3: Incorporate an Innovative Knowledge Approach within the Food Processing Industry

Significant amount of resources should be channelled to facilitate innovative knowledge approach in food processing industry.

- Put in place policies to encourage foreign and local firms to use locally manufactured food ingredients. This will provide a much-needed boost to the industry and the local economy.

- Develop a 21st century logistic network that is seamlessly integrated supply chain that connects the upstream and downstream industries to food processing manufactures in the global food supply network.

- Local food firms to invest in deep market understanding and assessment of market opportunities, and evaluate how they can position to exploit them.

- Focus on niche areas such as halal food; explore local cuisine and specialist foods to develop new market opportunities.

- Invest in talented chefs as well as food technologists to translate ideas to viable products that can be packaged, preserved and delivered to the market place whilst retaining freshness and taste.

Best Practice: ***Case-Study 14.3 – The US Cold Chain System.***

Recommendation 14.4: Develop the Knowledge Capital of the Food Processing Industry

To ensure knowledge capital of the industry, vocational education relating to food processing and food manufacturing must be strengthened. This is to ensure that current and future needs of specialized skills and knowledge pertaining to food science, such as food technologist, nutritional therapist, food safety inspector, food toxicologist, are met.

- Industry to create joint programs with key vocational colleges/universities such as Berjaya, and food science colleges to devise training, apprenticeship and internship to ensure individuals are “work-ready.”

- Affordable training programs to continuously upgrade the skill-set of the workforce should be in place, especially to serve training needs of SMEs.

- Training and development should not be focused on purely technical areas (GMP, HACCP, etc.) but also cover marketing and branding.

Best Practice: ***Case-Study 14.4 – Institute of Food Technologists***

Recommendation 14.5: Develop the Knowledge Competency for the Food Processing Industry

To ensure a high knowledge competency of the food processing industry, involvement of key industry bodies and federations in conducting industry fore-sighting is important.

- Increase the number and relevance of programs in colleges, polytechnics and universities on agri-food and food-processing, food technology and science.

- Develop strong internship and work placement programs. These programs should be certified by a professional industry based council (e.g. Canadian Food Processing Human Resources Council comprised by leading food manufacturers on the board).

- Establish National Food Processing Research and Training Centre to Malaysian firms to increase their global competitiveness in the food production areas through the development of innovative purification and extraction processes; processes that are energy efficient, reduce waste materials, and are environmentally friendly.

- Develop the competency framework to professionalize the workforce and create career paths for workers in food processing industry.

- Undertake novel biotechnology R&D that will improve shelf-life of food products without the need for chemicals and preservatives.

- Undertake R&D in innovative bioprocessing leading to new innovative and high value products that enhance the quality of agriculture, dairy and the nutraceutical industries.

Best Practice: ***Case-Study 14.5 – The Canadian Food Processing Institute, Food Processing Human Resources Council (FPHRC).***

Recommendation 14.6: Facilitate Knowledge Learning & Transfer within the Food Processing Industry

Collaboration between industry, universities, associations and government agencies is important to facilitate knowledge learning and transfer that contributes to strategic development of food processing industry.

- Engage in University-Industry partnerships for success: there should be a multidisciplinary effort (engineering, IT, Agriculture, Science, Medicine, etc.) to uncover leading-edge scientific discoveries and engineering methods for the food processing industry to reduce cost, be environmentally friendly, adhere to global best practices and be competitive in the global food industry.

- Local firms to benchmark leading MNCs (Nestle, Kraft Foods, Mars, Kellogs, etc.) to understand how cross-disciplinary teams come together, share and use knowledge to develop highly successful food products for market introduction.

- Foster continuous learning opportunities for SMEs through affordable training programs and courses in areas of various global standards and best practices such as the Global Food Safety Initiative (GFSI), HACCP, BRC, SQF and Halal.

- Support SMEs, through the provision of technology grants, subsidies and expert advice on implementation strategy and mentorship, to upgrade their technology and systems to transform labour intensive tasks to more technology and knowledge intensive operations.

- Establish Food Marketing centre that is able to provide advice and assistance on food trends and strategies to penetrate international markets, and thus open up opportunities to build economies of scale.

Best Practice: ***Case-Study 14.6 – The Australian Research Council Training Centre for Food Processing Industry in the 21st Century at the University of Sydney.***

Best Practice: ***Case-Study 14.7 - Cornell University, College of Agriculture and Life Sciences, Northeast Centre for Food Entrepreneurship.***

Recommendation 14.7: Strengthen the Knowledge Leverage within the Food Processing Industry

Stakeholders of food processing and complementary industries work in partnership to facilitate knowledge leverage, and thereby ensure future success of the industry.

- Strong partnership between industries (such as agriculture, business services and machinery) to ensure nurturance of the ecosystem. This requires strategic alignment of the industries to create space for win-win partnerships to flourish.

- Integrated ecosystem approach to encourage and attract greater R&D initiatives, innovation and development of new product and technology within the industry.

14.5 Conclusion

This chapter provided information on the state of the knowledge ecosystem for the Malaysian food processing industry. Some of the key strengths and gaps within the Malaysian food processing knowledge ecosystem had been identified through empirical analysis. Referring to a range of best practices of global food processing countries, we discuss key policies and strategies to improve the Malaysian food manufacturers' knowledge intensity and innovative capability. The ultimate aim is to raise the overall dynamic capabilities of Malaysian food processing industry, thereby successfully translate knowledge enablers into stronger process improvement and product development, as well as economic performance of the industry.

Appendix for Chapter 14

Case-Study 14.1 – Food and Drugs Agency (FDA), USA.

The Food and Drug Administration is responsible for protecting the public health by ensuring the safety, efficacy, and security of human and veterinary drugs, biological products, and medical devices; and by ensuring the safety of USA's food supply, cosmetics, and products that emit radiation.

- Regulatory programs - Safety regulation vary widely by the type of product, its potential risks, and the regulatory powers granted to the agency. Governed areas include testing, manufacturing, labelling, advertising, marketing, efficacy, and safety of food products.

- Science and research programs - FDA carries out R&D activities to develop technology and standards that support its regulatory role, with the objective of resolving scientific and technical challenges before they become impediments.

www.fda.gov/

Case-Study 14.2/14.5 – The Australian Research Council Training Centre for Food Processing Industry in the 21st Century at the University of Sydney.

- The Centre is a unique collaboration between University of Sydney researchers from the faculties of Engineering and Information Technologies, Agriculture, Science, and Medicine and international biotechnology companies that push the frontier of knowledge in the field from a multidisciplinary perspective.

- The Centre is an important source of support for the industry adopting leading-edge scientific discoveries, engineering methods and designs for the food processing industry to reduce cost, be environmentally friendly, adhere to global best practices and be competitive in the global food industry.

- The Centre focuses R&D in areas that are strategic to the Australian food processing industry, such as process optimisation and biotechnology, which leads to following:

- Quality research in high value food products that are safe, healthy and will prevent and treat various chronic diseases.

- Discovery of cost effective ways of producing minerals, food produce that uses less energy, is environmentally friendly and reduces waste.

- Identification of new techniques and methods to reduce spoilage and increase shelf-life of perishable food and products.

- The Centre also conducts workshops and training for next generation experts and talent in food technology and manufacturing, transferring knowledge and technology to local industry. (The University of Sydney, 2016)

http://sydney.edu.au/engineering/research/biotechnology-food/

Case-Study 14.3 - Institute of Food Technologists (IFT)

- To advance the science of food and its application across the global food system by creating a dynamic forum to facilitate collaboration, learning, and transforming scientific knowledge into innovative solutions.

- Organize the world's largest annual food science event.

- Publish Food Technology magazine.

- To facilitate personal development in food industry which involves exchanging experiences and knowledge, both in-person and online, so that food professionals are better prepared to meet the demands of a global food system.

- Offer a variety of new educational opportunities featuring respected scientists and research experts in food science and technology.

- Short courses taught by top academicians and industry leaders, such as Flavour Interactions in Foods, Strategies to Reduce Sodium, and Innovation with Healthier Grains & Oils.

- Organize competition and award programs for students to gain real world experience and recognition for their innovative ideas. This includes Developing Solutions for Developing Countries Competition, Disney–IFTSA Product Development Competition, etc.

- Food4Thought programming, focused on sensory activities and flavour science from Edlong Dairy Technologies, a mini product development competition with PepsiCo and Del Monte, and a glimpse behind-the-scenes about space food from NASA Johnson Space Centre, giving students a unique opportunity to learn more about food science careers.

- The LEAD 360 program provides leadership training and global networking for young food science professionals, to assist them in continuing to advance careers in food processing industry.

http://www.ift.org/about-us.aspx

Case-Study 14.4 - The Canadian Food Processing Institute, Food Processing Human Resources Council (FPHRC).

- FPHRC is a non-profit council established in 2009, comprising major food processing industry leaders on the board of FPHRC, who ensure that the workers in this industry have access to state-of-the art training and educational programs that will enhance global competitiveness of the industry.

- The FPHRC has also developed a competency framework to professionalise the workforce and create career path for workers in this industry.

- The Institute has designed courses and training programs using a variety of affordable leaning tools (e-learning platforms) and competency in the courses are continuously enhanced to ensure the workforce have the necessary skills and knowledge to make the industry a global leader in food processing.

- The FPHRC/Institute also provides training, certification and accreditation services on various global standards and best practices such as the Global Food Safety Initiative (GFSI), HACCP, BRC, SQF and Canada GAP. (Food Processing Human Resources Council [FPHRC], 2016).

www.fphrc.com/

Case-Study 14.6 - The US Cold Chain System.

- USA has one of the most sophisticated transportation and logistics network systems (road, rail, air and sea) equipped with temperature controlled containers and facilities using advanced technology and a GPS system. The cold chain system is crucial for perishable food products that are transported across the globe. The US has the largest cold 3rd Party Logistics (3PLs) sector, which provides a system to integrated warehousing and transportation services to businesses on an outsourced basis, with extensive reach in other continents. The latter helps American food producers extend their market reach to the global community in an efficient way and on time.

- The sophisticated cold chain system in the USA is also attributed to strong collaboration between industry, government, trade/industry associations and enforcement agencies in ensuring the following: transparent policymaking; strong technical regulations, standards and procedures for ensuring highest service quality; zero-tolerance for rent seeking and moral hazard behaviour; and a legal system that enables firms to resolve legal disputes quickly.

http://www.gcca.org/

Case-Study 14.7 - Cornell University, College of Agriculture and Life Sciences, Northeast Center for Food Entrepreneurship.

The Northeast Centre for Food Entrepreneurship (NECFE) started as a joint effort to expand the activities of the NYS Food Venture Centre at Cornell University and the Centre for Food Science at the University of Vermont, with the main aim to provide comprehensive assistance to beginning and established food entrepreneurs, thus promoting sustainable economic development of rural communities. The Centre provides educational materials, workshops, direct assistance, and referrals to appropriate organizations, in the following areas:
Product Process Development

- Product Safety Evaluation

- Guidance in local, state and Federal Regulatory Compliance

- Linkages to Business Assistance and Potential Financing Sources

- Referrals to Local Suppliers and Service Providers

- Funds for loans and grants are not available through this program.

Through the centre, entrepreneurs have access to established Cornell facilities such as:

- Analytical Laboratories

- Fruit and Vegetable Technology Pilot Plant

- Vinification and Brewing Technology Laboratory

- Food Processing and Development Laboratory

- USDA Approved Meats Laboratory

- Dairy Pilot Plant

http://necfe.foodscience.cals.cornell.edu/

References:

1. Hartman, L. R. 02 September 2015, Global Packaged Food Market by 2020 will be a $3.03-Trillion Industry, Food Processing: The Information Source for Food and Beverage Manufacturers. http://www.foodprocessing.com/industrynews/2015/global-packaged-food-market-by-2020-will-be-a-3-03-trillion-industry/ accessed on 23 September 2016

2. Oxfarm 26 February 2013, Behind the brands: Food Justice and the “Big 10” food and beverage companies. https://www.oxfam.org/sites/www.oxfam.org/files/bp166-behind-the-brands-260213-en.pdf accessed on 23 September 2016

3. Fusaro, D, 12 September 2016, Is the Food & Beverage Industry Poised for ‘Age of Innovation’? Food Processing, http://www.foodprocessing.com/industrynews/2016/poised-for-age-of-innovation/ accessed on 23 September 2016

CHAPTER 15

KNOWLEDGE CONTENT OF THE MALAYSIAN WHOLESALE INDUSTRY

CHAPTER 15
Knowledge Content of the Malaysian Wholesale Industry

15.0 Introduction

Wholesale industry consists of industrial wholesale trade (such as construction materials, equipment, supplies, etc.) and consumer wholesale trade (including clothing, groceries, etc.). The wholesale industry influences the overall nation's economy as it is an integral part of the supply chain for other sectors such as construction, manufacturing and retail. The industry plays an essential intermediary role in the economy between manufacturers and customers. In the industrial wholesale trade, the wholesaler's role is beyond buying and selling - additional services and expertise is required in offering technical advice, and even installation and maintenance services. For example, if new equipment or raw supplies are offered, wholesalers may have to assist customers in integrating it into their existing operation.

In Malaysia, the market for hypermarkets continues to be dynamic in 2016. For example, UAE-based LuLu supermarket opened its first hypermarket in Malaysia in June 2016. The group also announced its plans to invest US$ 300 million (RM 1.3 billion) as part of its expansion and intends to set up 10 hypermarkets in the next 5 years in Malaysia (*Saudi Gazette, 27 June 2016*). Similarly, GCH Retail, which has four wholesale and retail banners (Giant, Cold Storage Supermarkets, Mercato and Jasons Food Hall), currently operates 147 stores nationwide announced an upgrade to its 28 Giant hypermarket outlets and an additional four new Giant hypermarket outlets by mid-2016 (*The Star, 23 December 2015*).

In terms of industry structure, out of 370,725 establishments undertaking distributive trade services in Malaysia, 15.4% were engaged in wholesale trade activity. Despite the smaller proportion in the number of establishments, 52.2% of sales value of goods and services from distributive trade (RM841.6 billion in total) was contributed by wholesale trade in 2014. In addition, 30.2% of workers employed in the distributive trade (1.7million) were from the wholesale sector (Department of Statistics Malaysia, 2015).

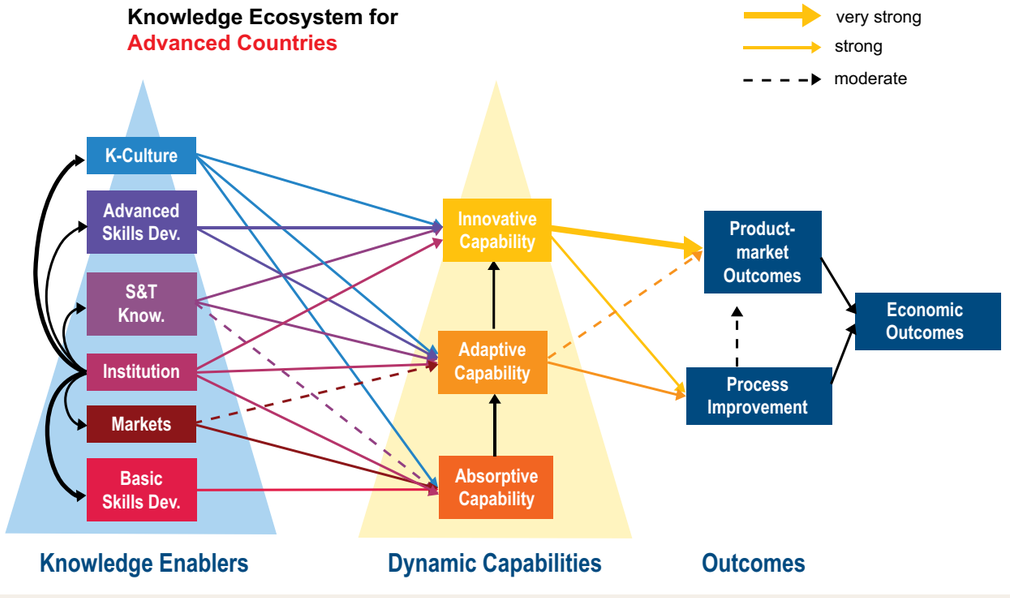
The chapter is organized as follows: In Section 15.1 a description of knowledge ecosystem of wholesale sector in an advanced economy is provided. In Section 15.2, we provide a description of the knowledge ecosystem for the Malaysian wholesale industry. In Section 15.3 the essay discusses the key strengths and gaps in the Malaysian wholesale knowledge ecosystem. In Section 15.4, the essay moves to key recommendations to improve the knowledge ecosystem of the Malaysian wholesale industry before concluding in Section 15.5.

Figure 4.1 demonstrates the relationship between knowledge enablers, dynamic capabilities and economic outcomes for advanced countries. As shown in the figure, the knowledge enablers for all three components of the dynamic capability are all very strong in advanced wholesale economy. Institutions (government agencies, trade associations and universities) in advanced countries play a dual role of developing the other enablers as well as directly influencing the dynamic capability components. Key components of the knowledge ecosystem for the wholesale sectors in advanced countries are discussed in the next section.

15.1 Knowledge Ecosystem in an Advanced Wholesale Economy

The knowledge ecosystem for the wholesale industry in advanced countries exhibit high levels of development and positive contribution to the economy. Knowledge enablers for the wholesale industry in advanced economies contribute positively to absorptive, adaptive and innovative capabilities, and therefore drive process improvement and new product development. All these contribute to economic outcomes. In other words, an investment in knowledge enablers helps in the development of dynamic capabilities that sustain the development

Figure 15.1: Complex Relationships in the Wholesale Industry in an Advanced Country



of wholesale industry. The following initiatives have been undertaken by wholesale industry in advanced countries:

- *Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Wholesale Industry*. Standards are important drivers of the wholesale industry. Standards relating to the environment and sustainability impact the logistics component of the wholesale operations, while emerging industry practices such as IoT and Industry 4.0 are defining new practice standard across the entire supply chain of wholesale industry. Other standards include the Development of Community Guide to Good Hygienic Practices Specific to Wholesale Market Management in the European Union. *Best Practice:* ***Case-Study 15.1 – World Union of Wholesale Markets.***

- *Knowledge Institutional System of the Wholesale Industry* – Government in partnership with different stakeholders actively develops an institutional set-up for the industry that coordinates and implements strategies to advance the wholesale industry to a higher competitive platform. *Best Practice:* ***Case-Study 15.2 – Fraunhofer Institute.***

- *Innovative Knowledge Approach within the Wholesale Industry* – Advanced technology is adopted to create seamless integration of all processes within the wholesale value chain from translation of R&D outcomes, improving operational efficiencies, developing new products and support services; and creating new revenue streams from the development of new line of products and services. *Best practice:* ***Case-Study 15.6 - Council for Research on Distributor Best Practices (CRDBP), with Texas A&M University.***

- *Knowledge Capital of the Wholesale Industry* – The wholesale workforce is upskilled and developed through a wide range of training programs and courses from non-award certification training programs to more formal qualifications such as diploma, undergraduate, postgraduate and research programs. *Best Practice:* ***Case-Study 15.3 - National Association of Wholesalers and Distributors (NAW), USA***.

- *Knowledge Competency for the Wholesale Industry* – Implementation of a clear map of the skill set needed by the industry. This is accompanied by a systematic framework to track and align with the changing landscape of the industry and its need for new forms of skills and competencies. *Best Practice:* ***Case-Study 15.4 - Federation of Wholesale Distributors, UK.***

- *Knowledge Learning & Transfer within the Wholesale Industry* – A sound integrated framework is in place for the wholesale industry of advanced countries to identify and develop the key priority areas through S&T and R&D. This process creates spill-over benefits for industry. *Best Practice:* ***Case-Study 15.5 – Creating an Entire Global Online Business: Alibaba Group, China.***

- *Knowledge Leverage within the Wholesale Industry* – Institutions (government agencies, industry association and educational institutions) play a key role establishing platforms and forums of exchange of information and knowledge that help strengthen and develop the industry. *Best practice:* ***Case-Study 15.7 - Council for Research on Distributor Best Practices (CRDBP), with Texas A&M University.***

15.2 Knowledge Ecosystem of the Malaysian Wholesale Industry

In this section, a brief description of the knowledge ecosystem for the Malaysian wholesale industry is provided. The analysis is based on survey data collected from 679 firms, out of which 219 are large firms and 460 are small firms. A majority of the firms are local firms (n = 591) and only a small number are foreign firms (n = 88). Figure 15.2 shows the state of development of the knowledge enablers. All enablers perform at a moderate level, with the exception of institutions and S&T Knowledge which scored below 0.4.

Figure 15.3 shows the dynamic capability components, process improvement and product development in the Malaysian wholesale and that of a comparable industry from an advanced country. The dynamic capability components, process improvement and product development were measured for large, SMEs, local and foreign firms. The dynamic capability as well as process improvement and product development for advanced countries were found to be higher than that of the Malaysian wholesale industry. Within the Malaysian wholesale industry, foreign firms have higher dynamic capability and product development than local firms. Larger firms also have higher process improvement than SMEs.

Figure 15.2: Knowledge Enablers for the Malaysian Wholesale Industry

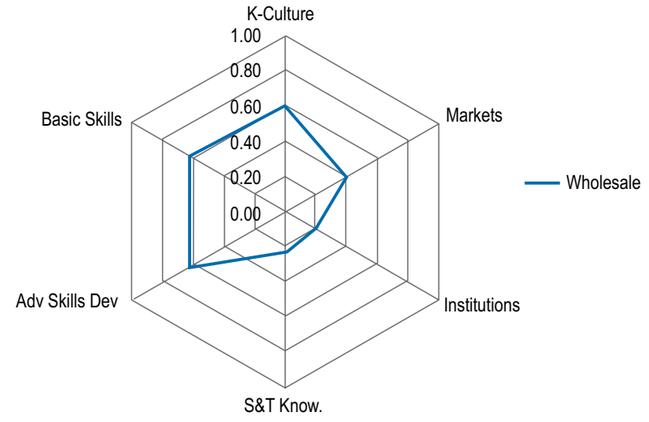
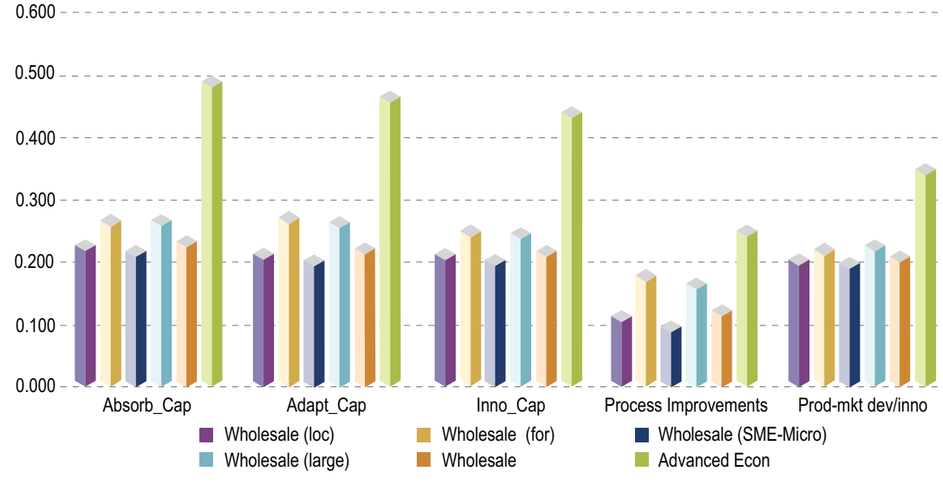


Figure 15.3: State of the Dynamic Capabilities of the Malaysian Wholesale Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

The strategic postures of firms in the Malaysian wholesale industry are given in Figure 15.4. The figure shows that a majority of firms are Analyser (over 35%), followed by Defender (over 12%) and Reactor (12%) firms. Only 6% of the firms in the wholesale industry are Prospector firms. This suggests that only a small proportion of firms in the wholesale industry take part in innovation activity in a proactive, long-term manner.

The knowledge ecosystem for the wholesale industry is shown in Figure 15.5. Results show that basic skills development does not contribute to absorptive capability among wholesale firms in Malaysia. A large number of operational staff at the wholesale's ground level tend to be foreign low-skilled labourers. In addition, markets do not impact on absorptive and adaptive capability among wholesalers in Malaysia. This suggests that the wholesalers do not actively scan and study their markets (including their competitors and customers) to absorb new knowledge in order to develop the wholesale industry. Institutions have negative impact on adaptive capability and no impact on innovative capability. S&T knowledge and advanced skills development among wholesalers fails to impact innovative capability. Wholesalers in Malaysia demonstrated strong impact of knowledge culture in the process of developing dynamic capabilities.

Figure 15.4: Strategic Posture of the Firms in the Malaysian Wholesale Industry

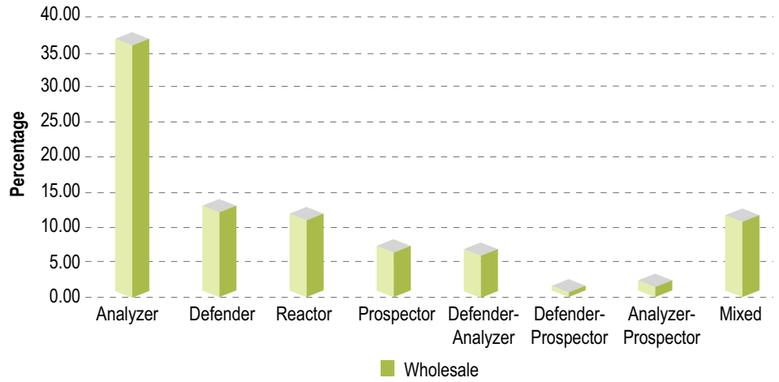


Figure 15.5: Knowledge Ecosystem of the Wholesale Industry

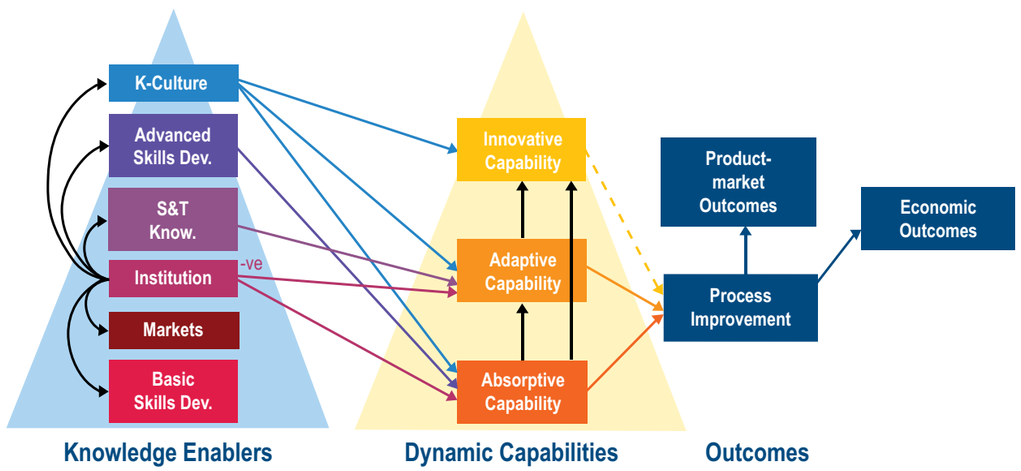
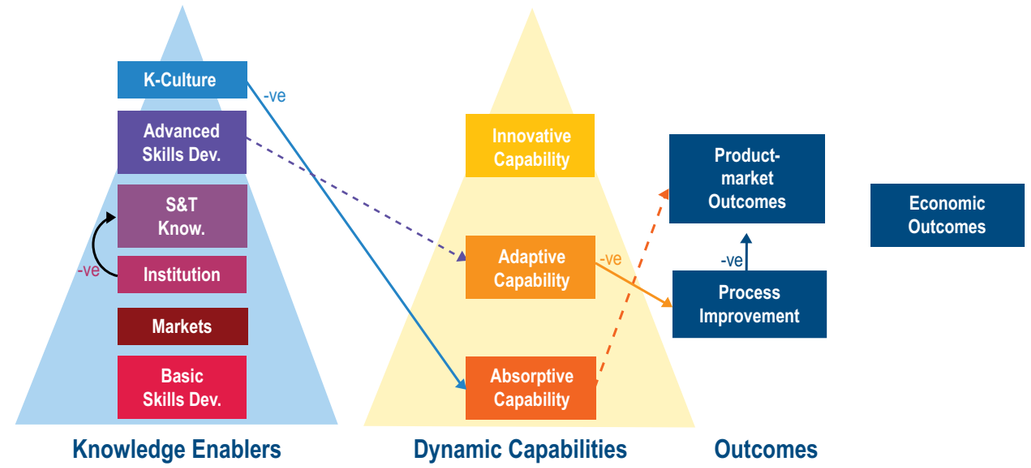


Figure 15.6: Knowledge Ecosystem for Wholesale Large vs Wholesale Micro-SME



Results also show that in addition to building absorptive capability, adaptive capability and innovative capability in sequential manner (like most advanced economies), there is a strong direct impact from absorptive capability on innovative capability. Interestingly, innovative capability fails to impact on the innovation of products/services; however, it has a strong impact on process improvement.

The wholesale ecosystem was compared for large and micro-SME firms and results of the multi-group analysis are presented in Figure 15.6. The results show that for both large and small wholesalers, the contribution of basic skills development to dynamic capability building is not significant. Markets have no impact on building dynamic capabilities for both large and small wholesalers, suggesting that wholesalers of all sizes in Malaysia continue to underestimate the power of data in improving their business. The influence of institutions on S&T knowledge is significantly higher among small wholesalers as compared to large wholesalers. Unlike large wholesalers who can independently source advanced S&T knowledge, small wholesalers rely heavily on institutions, including government agencies, associations, and research and education institutions, to develop and upgrade their knowledge capabilities. With limited financial resources and limited access to reputable S&T knowledge vendors, it can be definitively concluded that small wholesalers acquire S&T knowledge through institutional help.

Advanced skills development contributes to adaptive capability. It is significantly higher among large wholesalers as compared to small wholesalers. Large wholesalers are much more likely than small wholesalers to invest in advanced skills development (such as advanced inventory management, advanced supply chain management, etc.) due to economies of scale. Large wholesalers typically deal with huge amounts of stocks and a large number of employees working in different points of the entire wholesale system. The large size conduces economies of scale and makes it feasible for these firms to invest in upgrading employees' skills. Such investments generally involve high costs and even large wholesalers tend to cautiously make such investment. They want to ensure that advanced skills learnt are internalized and adopted within the organization to improve existing operations and not be lost due to skilled workforce turnover. Knowledge culture influences absorptive capability of small wholesalers more significantly as compared to large wholesalers. With lower number of employees, flexible organizational structure and fewer layers of reporting between top management and employees (especially those at the sales floor), it is easier to cultivate a knowledge sharing culture within small wholesale firms.

The analysis also demonstrates that absorptive capability contributes to product/market innovation more significantly among large wholesalers as compared to smaller firms. Instead of building dynamic capability in a sequential manner from absorptive to adaptive, then to innovative capability, and hence contributing to service innovation (like most large firms in advanced economies), large wholesalers in Malaysia attempt to utilize whatever new information/knowledge they can pick up and use it within the organization to create new service offerings. Unfortunately, they do this without fully internalizing the acquired knowledge within the organization through sufficient development of adoptive and innovative capability.

Finally, results show that adaptive capability contributes to process improvement more significantly among small wholesalers as compared to large firms. Subsequently, process improvement leads to product/market innovation much strongly among small wholesalers as compared to large wholesalers. This suggests that small wholesalers are strongly focused on trying to leverage knowledge to improve their wholesale processes.

15.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Wholesale Industry

Based on the analysis of the knowledge ecosystem of the wholesale industry, the key strengths and gaps of the ecosystem are provided in this section of the report:

Key Strengths of the Wholesale Ecosystem:

- With rising spending power among Malaysians as well as the growth of the tourism industry, the future of wholesale industry in Malaysia is promising.

- The local wholesalers have extensive experience of competing with well-established global brands. Through this process, they have built substantial knowledge and resources for competition.

- Strong demand from industrial wholesale trade (such as construction materials, equipment, supplies, etc.) continues to play a critical role in contributing to the steady growth of Malaysia's industrial economies.

Key Gaps of the Wholesale Ecosystem:

- A large number of employees are foreign workers. Little basic skills development takes place resulting in wholesale staff who are not service-oriented and make little contribution to the dynamic capabilities building of the industry.

- There is spartan use of market intelligence to build dynamic capabilities within the wholesale industry. Without adequate market intelligence, there is a lack of awareness of global trends. Hence, many local firms do not keep pace, especially with advanced techniques.

- Institutions appear to play a negative role in the dynamic capabilities of wholesalers. Frequent changes in policy and regulations, as well as ambiguity in implementing new policy and regulations dampen the capability of wholesalers to effectively internalize their learnt knowledge. Considerable effort and time is required for wholesalers to cope with demands made by government bodies. This leaves them with little and/or no resources to internalize new knowledge.

- S&T knowledge and advanced skills development among wholesalers fail to impact innovative capability, suggesting that innovative business models (such as the omnichannel strategy used in many advanced economies) requiring advanced wholesale skills and high technology are not sufficiently developed to benefit the wholesale industry in Malaysia.

- Dynamic capabilities of wholesale industry are not built in a sequential manner. Quick leap-frog attempts can lead to waste of resources because investment in knowledge leads to poor innovative outcomes when it is not sufficiently internalized.

- Wholesalers' effort to improve their innovative capability contribute significantly to improve their existing processes. However, such effort does not translate into innovative services. Most wholesalers in Malaysia still operate business conventionally. It seems that adopting innovative business models (such as those implemented in advanced economies) remain a distant goal for Malaysian wholesalers.

15.4 Recommendations to Improve the Malaysian Wholesale Knowledge Ecosystem

Despite major shortcomings in innovation, the wholesale industry remains a big contributor to Malaysia's economy. To ensure viability and competitiveness of the Malaysian wholesale industry, the following recommendations are proposed to strengthen the knowledge ecosystem and knowledge content of the industry.

Recommendation 15.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Wholesale Industry

Global best practices and standard should be the benchmark for Malaysian wholesale industry to continue to excel. Best practices and standards for supply chain procurement, warehousing and storage, shipment containers and containers labelling, need to be contextualized and implemented for Malaysian conditions.

- ❑ Industry association takes the lead in stipulating and governing standards of practice in wholesale sector.

- ❑ Implement Industrie4.0 Warehouse and handling processes.

- ❑ Develop infrastructure to promote and protect local wholesalers while opening the market for foreign wholesalers for healthy and vigorous development of the industry to attain international standards.

Best Practice: ***Case-Study 15.1 – World Union of Wholesale Markets.***

Recommendation 15.2: Enhance the Knowledge Institutional System of the Wholesale Industry

Various stakeholders play different and complementary roles in the knowledge institutional system of wholesale industry. Continual interaction and cooperation among government agencies, trade associations, and education institutions is important to ensure that the knowledge institutional system is well established to build dynamic capabilities of wholesale industry in Malaysia. To facilitate this, a number of steps can be undertaken:

- ❑ Increase coordination and collaboration between trade associations, government agencies, and universities to drive change in the industry.

- ❑ Bring together wholesale expertise from relevant institutes, associations and consultants into a single location whereby wholesalers can access higher continuing education, share deeper insights and experiences.

- ❑ Develop approaches that tie wholesale operations seamlessly to key segments they serve (construction, consumer facing, furniture and furnishing, textile and apparel, commodities and mining etc.) and develop higher value add propositions through support activities that they need and are unable to efficiently execute.

Best Practice: ***Case-Study 15.2 – Fraunhofer Institute.***

Recommendation 15.3: Incorporate an Innovative Knowledge Approach within the Wholesale Industry

Strong collaboration between industry, universities, associations and government agencies to develop more efficient and productive wholesale operations are important for the strategic development of wholesale and complementary industries. However, to realise the impact of these interactions it is necessary to:

- ❑ Invest in new emerging technologies to ensure state of the art wholesale experience.

- ❑ Collaborate or partner with global wholesalers to compete as a network rather than isolated players.

- Utilize 3PL approach to develop a strong wholesale and distribution network.

- Create strong local brands through the crafting of effective marketing strategies. This will help establish a stronger footing for both local firms and SMEs.

- Strategically plan geographic dispersion of different type of retailers and wholesalers to facilitate balanced growth and access throughout the industry and country.

- Systematic civic planning and infrastructure planning to ensure a flourishing retail and manufacturing sector with whom wholesalers trade.

Best practice: ***Case-Study 15.3 - Council for Research on Distributor Best Practices (CRDBP), with Texas A&M University.***

Recommendation 15.4: Develop the Knowledge Capital of the Wholesale Industry

Wholesale industry has to work closely with educational institutions to ensure courses and programmes create the range and level of skills required by the industry. In particular, the pool of professional wholesale workforce must be made ready to handle emerging technologies that drive change in the wholesale sector.

- Provision of training to develop skills that make Wholesale sector ready for IT based environments.

- Skills need to be strengthened in the areas of inventory management, databases, online purchasing, EDI, as well as new selling techniques though emerging media, and RFID technologies.

- The industry and relevant institutions must work towards creating a positive outlook within the industry through wage/salary revisions, structured career pathways. This is to attract skilled graduates to the industry.

- Affordable training programs to continuously upgrade the skills set and service levels of the workforce. This should be conducted jointly with key colleges/universities working in partnership with industry.

Best Practice: ***Case-Study 15.4 - National Association of Wholesalers and Distributors (NAW), USA.***

Recommendation 15.5: Develop the Knowledge Competency for the Wholesale Industry

Future skill needs in wholesale industry such as security and loss prevention, supply chain management, logistics, new modes of buying and distributing, must first be mapped out. Following this, collective actions must be taken by higher education institutions and industry association to ensure quality and quantity of wholesale workforce is available for long term success.

- Foster strong education institutions-industry collaboration in the development of emerging competencies needs such as the ICT, cloud computing and data analytics.

- As the wholesale sector comes under stronger disintermediation pressure it will be necessary to develop stronger customer relationships through enhanced “total solutions” development particularly through IT based e-commerce platform.

- Integrate processes with retail clients to develop seamless experiences. Develop door to door total solutions with built in customer facing service quality processes.

- Develop competencies in IT and tracking for customer service delivery.

Best Practice: ***Case-Study 15.5 - Federation of Wholesale Distributors, UK.***

Recommendation 15.6: Facilitate Knowledge Learning & Transfer within the Wholesale Industry

A strong industry network with shared collective vision of overall development has to be established to facilitate knowledge transfer within the wholesale industry. Regular dialogue and an exchange of information between wholesalers and respective institutions should be initiated and sustained. The following activities will facilitate this process:

- Strategies and programs of various higher learning institutions need to better align with needs of wholesalers.

- To set-up shared facility or centres to support firms in particular areas and other specialized needs within the supply chain. For example, to train small firms in leading wholesale technologies, such as auto-packaging, picking, location and order tracking.

- Industry associations to take the lead to systematically collect, analyse and utilize data in helping the industry to make business decisions. Use of data analytics to help improve decision making, especially to remove bottlenecks in system, as well as create cost reduction efficiencies. This type of knowledge must be shared across the industry.

- Foster continuous learning opportunities for SMEs through affordable training programs and courses via universities, colleges, polytechnics, training institutes etc. particularly in areas of ICT.

Best Practice: ***Case-Study 15.6 – Creating an Entire Global Online Business: Alibaba Group, China.***

Recommendation 15.7: Strengthen the Knowledge Leverage within the wholesale Industry

Stakeholders of wholesale and complementary industries must work in partnership to facilitate knowledge leverage, and thereby ensure future success of the industry. Emerging technologies in wholesale industry and complementary industries have to be taken into consideration to strengthen knowledge leverage of wholesale industry. A number of actions will help improve knowledge leverage, such as:

- Equip the industry with the necessary technological sophistication to facilitate the transition to a “cashless society.”

- Integrate with large retail supply chain to ensure value-add in areas that local firms are unable to manage with ease.

- Promote adoption of technology in wholesale operation such as RFID (Radio-Frequency Identification) to improve efficiency.

- Build technological infrastructure to support the industry’s move towards ICT.

Best practice: ***Case-Study 15.7 - Council for Research on Distributor Best Practices (CRDBP), with Texas A&M University.***

15.5 Conclusion

This chapter analyses and discusses the state of the knowledge ecosystem for the Malaysian wholesale industry. The key strengths and some of the gaps within the Malaysian wholesale knowledge ecosystem are identified through the analysis. Building on some best practices from advanced wholesale economies, some recommendations were made to strengthen the knowledge enablers and to fill the identified gaps within the current knowledge ecosystem. Ultimately, the aim is to alleviate the dynamic capabilities of the Malaysian wholesale industry, which could translate into greater process improvement, product development and economic outcomes of the industry.

Appendix for Chapter 15

Case-Study 15.1 – World Union of Wholesale Markets.

A non-profit association that aims to promote the international exchange of information on wholesale and retail markets, WUWM's goals are:

- To develop and promote the international exchange of information on wholesale and retail markets so as to improve the construction, organisation and administration of member markets;
- To participate in the activities and issues of wholesale and retail markets, as well as production markets or markets at point of origin;
- To exchange experiences, skills, knowledge and expertise for the overall benefit of the membership;
- To develop and promote the important relationship existing between market authorities, operators, traders and businesses on the market.

www.wuwm.org/

Case-Study 15.2 – Fraunhofer Institute.

Germany's Fraunhofer Institutes are active across the country in developing new technologies. The education system is world-class, and deploys a dual education system in which in-class theory is melded with on-the-job training to create a pool of flexible and highly skilled labour.

- 60 institutes in more than 250 areas of specialisations are paired with universities with similar academic and research interests.
- There exists a strong government-industry partnership and significant resources are channelled into industry by partnered federal and state government to develop state-of-the-art research infrastructure, academic programs (undergraduate to post-doctoral training) and factory internship.

https://www.fraunhofer.de/en.html

Case-Study 15.3 – Creating an Entire Global Online Business: Alibaba Group, China.

Alibaba of Chin is, a major global e-commerce company with various online business facilitation services. Alibaba business model includes consumer-to-consumer, business-to-consumer and business-to-business sales services via its web portals. The portal provides online sales and service to consumers regardless of size of the transactions. It also has a wider reach than most retail stores or portals to customers. It executes both wholesale and retail activity within an integrated online system.

www.alibabagroup.com/

Case-Study 15.4 - National Association of Wholesalers and Distributors (NAW), USA.

NAW is a national association of wholesaler-distributors that advocate its members' interests on national public policy issues that affect the entire wholesale distribution industry.

- NAW Political Action committee - to mobilize the involvement of wholesaler-distributors in the federal electoral process through financial contributions and political education activities
- NAW Institute for Distribution Excellence - To sponsor and disseminate research into strategic management issues affecting the wholesale distribution industry.
- NAW service Corporation - To sponsor industry-wide service and product offerings that benefit wholesaler-distributors.

https://www.naw.org/

Case-Study 15.5 - Federation of Wholesale Distributors, UK.

The Federation of Wholesale Distributors is the member organisation for UK wholesalers operating in the grocery and foodservice markets supplying independent retailers and caterers via cash and carry, delivery and the Internet. It is involved in:

- Campaigning - FWD champions the cause of members through regular contacts with ministers, MPs and officials.
- Communication – FWD keeps members informed on legislative issues.
- Collaboration – member committees share intelligence and best practices on security and legal issues.
- Co-operation – work with suppliers to increase understanding of the wholesale channel and its potential.

www.fwd.co.uk/

Case-Study 15.6/15.7 - Council for Research on Distributor Best Practices (CRDBP), with Texas A&M University.

The NAW Institute for Distribution Excellence and Texas A&M University are engaged in an alliance dedicated to furthering the understanding and application of best practices in wholesale distribution. This alliance created the Council for Research on Distributor Best Practices (CRDBP). Its mission is to create strategies for competitive advantage for distributors through development of research, tools, and education.

The CRDBP organizes and operates educational consortia on important business topics for interested wholesale distribution companies of all sizes and lines of trade.

http://www.naw.org/crdbp/about.php.

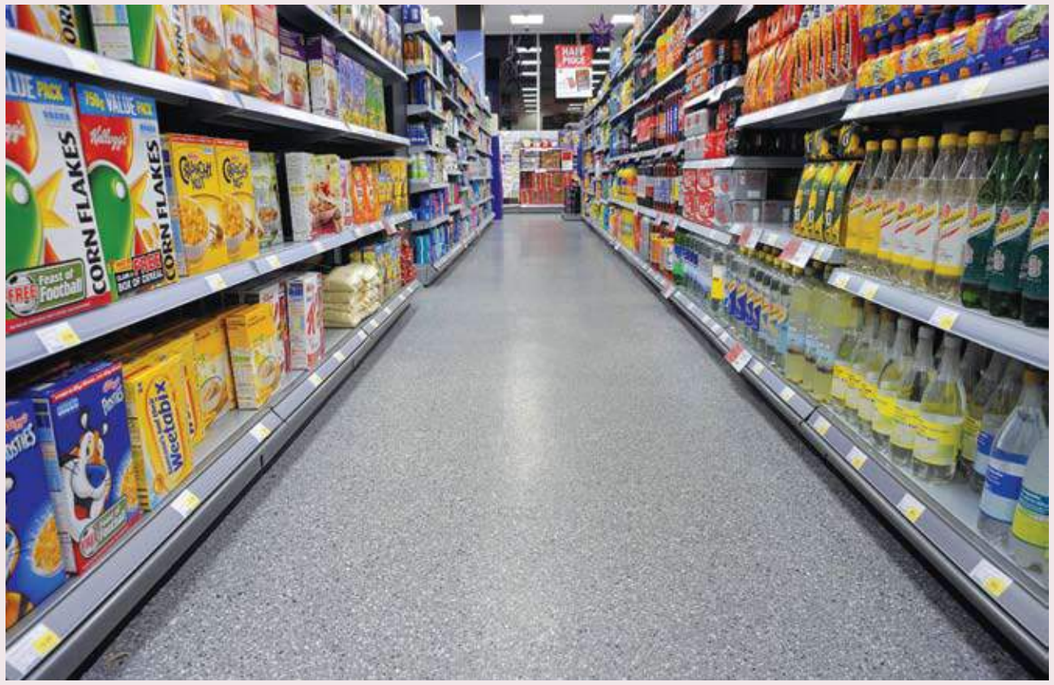
References:

1. Department of Statistics Malaysia. (2015). Sales Value of Goods and Services for Distributive Trade Sector in 2013 Grew by 6.6% Compared to 2008. Retrieved from https://www.statistics.gov.my/index.php?r=column/cthemeByCat&cat=318&bul_id=U1FoUzF2WjBERmgzWHd5elZZVkNWQT09&menu_id=b0pIV1E3RW40VWRTUkZocEhyZ1pLUT09
2. First LuLu Hypermarket opened in Kuala Lumpur, *Saudi Gazette*, 27 June 2016, http://saudigazette.com.sa/business/first-lulu-hypermarket-opened-kuala-lumpur/, accessed on 20 September 2016.
3. GCH Retail to upgrade 28 Giant hypermarkets by early 2016, *The Star*, 23 December 2015, http://www.thestar.com.my/business/business-news/2015/12/23/gch-retail-to-upgrade-28-giant-hypermarkets-by-early-2016/, accessed on 20 September 2016.

CHAPTER 16

KNOWLEDGE CONTENT OF THE MALAYSIAN RETAIL INDUSTRY

CHAPTER 16
Knowledge Content of the Malaysian Retail Industry



16.0 Introduction

The retail industry depends heavily on domestic consumption and continues to play significant role in boosting Malaysia's economy. In 2014, together with wholesale industry, the distributive trade contributed to 12.7% of Malaysia's GDP (*ETP Annual Report 2014 on Wholesale and Retail,* PEMANDU). National retail sales in Malaysia were valued at USD93billion in 2015 (*The 2016 Global Retail Development Index*™, ATKearney). The retail industry Compound Annual Rate Growth (CARG) from 2013 to 2015 is -3.4%.

Retailers are the main players in distributive trade services in Malaysia, in which 70.3% of establishments (370,725 in total) are engaged with retail trade activity and contributed to 33.2% of sales value of goods and services (RM841.6 billion in total). In terms of employment, 53.6% of workers employed in distributive trade (1.7million) are from the retail sector (Department of Statistics Malaysia, 2015).

Based on relevant macroeconomic and retail specific factors, the Global Retail Development Index ranked the top 30 developing countries for retail investment. Malaysia is in third position, after China and India, in the 2016 Global Retail Development Index (The 2016 Global Retail Development Index™, ATKearney), suggesting Malaysia to be a business-friendly environment, particularly for retail investment. This suggests Malaysia is an attractive destination for both international and domestic retailers. Investors remain optimistic about Malaysia's retail industry potential, despite slowing GDP growth and depreciation of the Malaysian currency. Malaysia's attractiveness as a retail location can be evidenced by the increasing opening of retail outlets. For example, 7-eleven Malaysia announced the opening and upgrade of 200 stores; Bison Consolidated Berhad which operates a chain of press and convenience retail outlets (under the names of myNEWS.com, newsplus, MAGBIT, THE FRONT PAGE, and WHSmith) also announced its plan to open 150 new stores by 2017. IKEA, the Swedish Furniture retailer, which specializes in ready-to-assemble furniture, also announced an investment of USD143 million (RM592 million) on its third store in Johor Baharu, Malaysia.

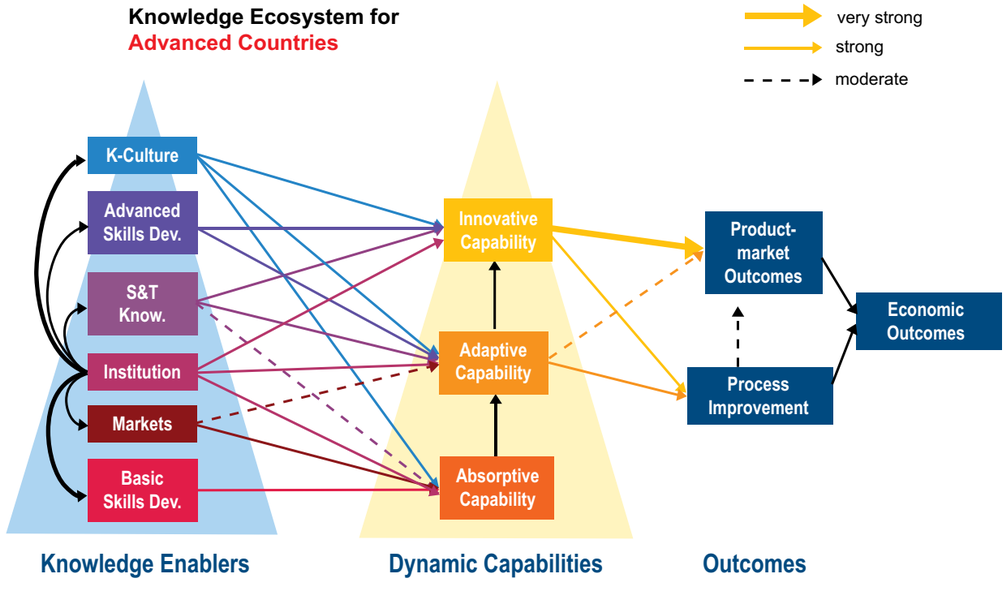
The chapter is organized as follows: In Section 16.1 a description of knowledge ecosystem of retail sector in an advanced economy is provided. In Section 16.2, we provide a description of the knowledge ecosystem for the Malaysian retail industry. In Section 16.3, the report discusses the key strengths and gaps in the Malaysian retail knowledge ecosystem. In Section 16.4, the report provides key recommendations to improve the knowledge ecosystem of the Malaysian retail industry before concluding in Section 16.5.

16.1 Knowledge Ecosystem in an Advanced Retail Economy

Figure 16.1 demonstrates the relationship between knowledge enablers, dynamic capabilities and economic outcomes for advanced countries. As shown in the figure, knowledge enablers for all three components of the dynamic capability feature strongly in advanced retail economies. Institutions (government agencies, trade associations and universities) in advanced countries have a dual role of ensuring the other enablers are strong enough to support dynamic capability components as well as directly influencing their development. Key components of the knowledge ecosystem for the retail sector in advanced countries are discussed in the next section.

The knowledge ecosystem for the retail industry in an advanced country exhibits a high level of development and positive contribution to the economy. Knowledge enablers for retail industry in advanced economies contribute to absorptive, adoptive and innovative capabilities, and thereby drive process improvement and new product development within the industry.

Figure 16.1: Complex Relationships in the Retail Industry in an Advanced Country



All of them collectively contribute to economic outcomes. In other words, the continued investments in knowledge enablers help in the process of building dynamic capabilities that sustain the development of the retail industry. The following characterize initiatives undertaken by retail industry in advanced countries:

- *Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the retail Industry.* The retail industry closely follows emerging trends, protocols of practices and standards that define retail practices. Retail players are active in developing standards and best practices. *Best Practice:* ***Case-Study 16.1 – Independent Retail Europe.***

- *Knowledge Institutional System works to facilitate development of the retail industry* – Government in partnership develop a facilitative institutional set-up for the industry and identify key priority areas of development and have implementation strategy clearly defined. *Best Practice:* ***Case-Study 16.2 – Global Retail Marketing Association (GRMA)***

- An Innovative Knowledge Approach within the retail Industry – The retail industry has increasingly adopted advanced technology to foster seamless integration of all production processes within the retail value chain. This helps translate R&D outcomes, improving operational efficiencies, developing new products and support services and creating new revenue streams. *Best Practice:* ***Case-Study 16.6 – Creating an Entire Global Online Business: Alibaba Group, China.***

- *Knowledge Capital of the retail Industry* – The retail workforce is professionalized by having a wide range of training programs and courses. These range from non-award certification training programs to formal qualifications, such as diploma, undergraduate, postgraduate and research programs. *Best Practice:* ***Case-Study 16.3 - Retail Academy of Singapore.***

- K*nowledge Competency for the retail Industry* – The skill set needed by the industry is clearly mapped out and there is framework in place to track the changing landscape of the industry. The framework helps institute review processes and upgrades competencies. *Best Practice:* ***Case-Study 16.4 - World Union of Wholesale Markets – Retail Sector.***

- *Knowledge Learning & Transfer within the retail Industry* – A sound integrated framework is in place in most advanced countries to develop key priority areas through S&T and R&D and ensure spill-over benefits are translated for industry. *Best Practice:* ***Case-Study 16.5 – Informatisation of the Korean Economy.***

- *Knowledge Leverage within the retail Industry* – Institutions (government agencies, industry association and educational institutions) play a key role establishing platforms and forums of exchange of information and knowledge to help firms build strong positions in the marketplace. *Best Practice:* ***Case-Study 16.7 - National Retail Federation, US***

16.2 Knowledge Ecosystem of the Malaysian Retail Industry

In this section, we provide a brief description of the knowledge ecosystem for the Malaysian retail industry based on survey data. The survey is made up of 1,139 firms in total, out of which 159 are large firms and 980 are small firms. In terms of country of origin, the majority are local firms (n = 1078) and only a small number of respondents firms are foreign firms (n = 61). Figure 16.2 shows the state of development of the knowledge enablers. All enablers perform at a moderate level, with the exception of institutions and S&T Knowledge (score below 0.4).

Figure 16.3 shows the dynamic capability components, process improvement and product development in the Malaysian retail and that of a comparable industry from an advanced country. The dynamic capability components, process improvement and product development were measured for large, SMEs, local and foreign firms. The dynamic capability, process improvement and product development for advanced countries are found to be significantly higher than that of the Malaysian retail industry. Within the Malaysian retail industry, foreign firms are found to have a higher dynamic capability and product development than local firms. Larger firms also have higher process improvement than SMEs.

Figure 16.2: Knowledge Enablers for the Malaysian Retail Industry

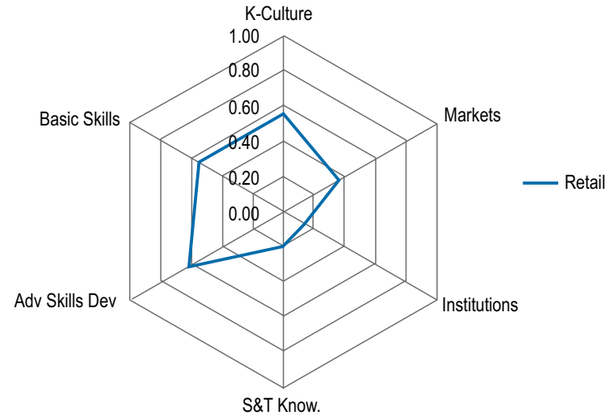
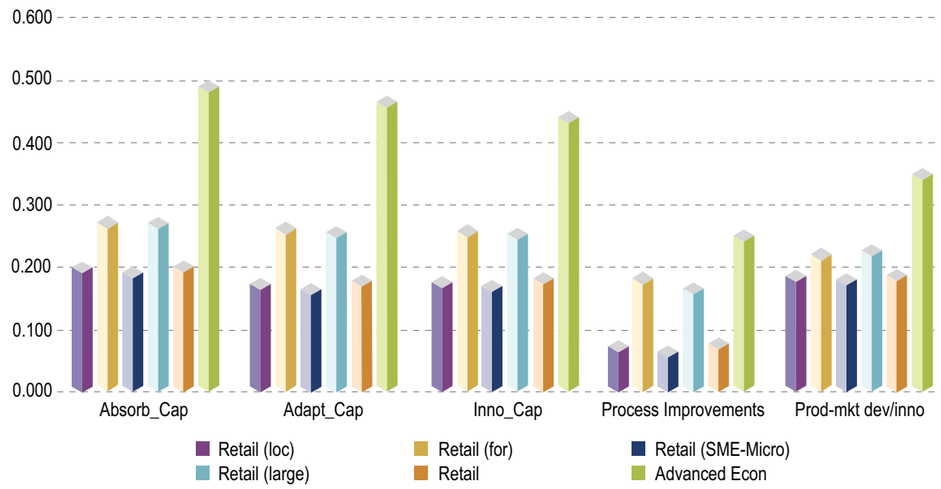


Figure 16.3: State of the Dynamic Capabilities of the Malaysian Retail Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries.

The strategic postures of firms in the Malaysian retail industry are given in Figure 16.4. The figure shows that a majority of firms are Analyser firms (over 35%), followed by Defender (over 12%) and Reactor (12%) firms. Only 6% of the firms in the retail industry are Prospector firms. This suggests that only a small proportion of firms in the retail industry invest in programs of innovative endeavour.

The knowledge ecosystem for the retail industry is shown in Figure 16.5. Results show that basic skills development of retailers contributes to absorptive and adaptive capability. Most retailers in Malaysia do not rely heavily on foreign workers for frontline jobs. Using local employees with basic education (at least up to high school), retailers internalize skills and knowledge (either through on the job training or formal training). Unlike wholesalers who are weak in scanning and monitoring markets, retailers in Malaysia are actively engaged in learning and absorbing knowledge about their markets. However, such market intelligence only contributes in building their absorptive capability but not adaptive capability. Results also show that institutions have negative impact on absorptive capability and no impact on adaptive and innovative capability among retailers. S&T among retailers in Malaysia has very strong impact on adaptive capability and strong impact on absorptive capability. However, it has no impact on innovative capability.

Figure 16.4: Strategic Posture of the Firms in the Malaysian Retail Industry

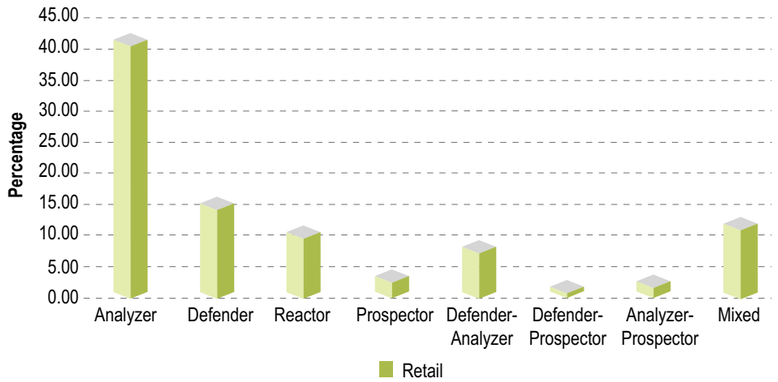


Figure 16.5: Knowledge Ecosystem of the Retail Industry

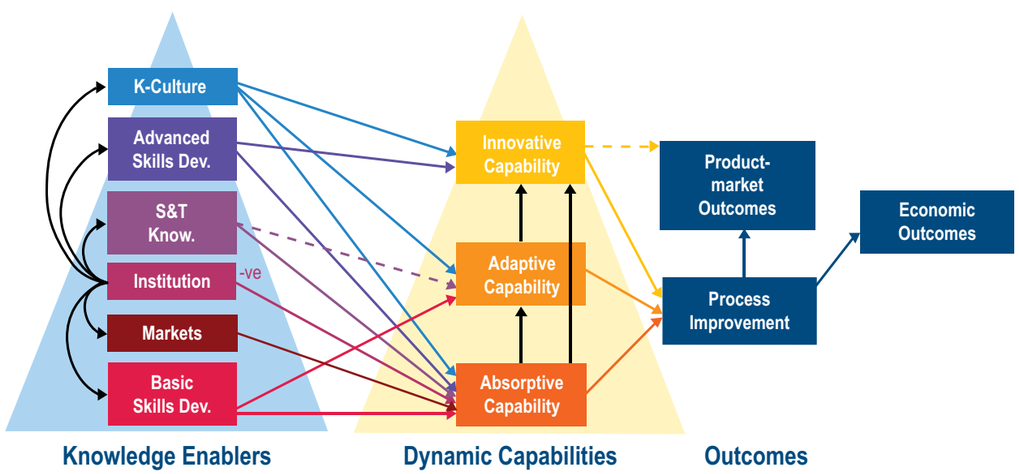
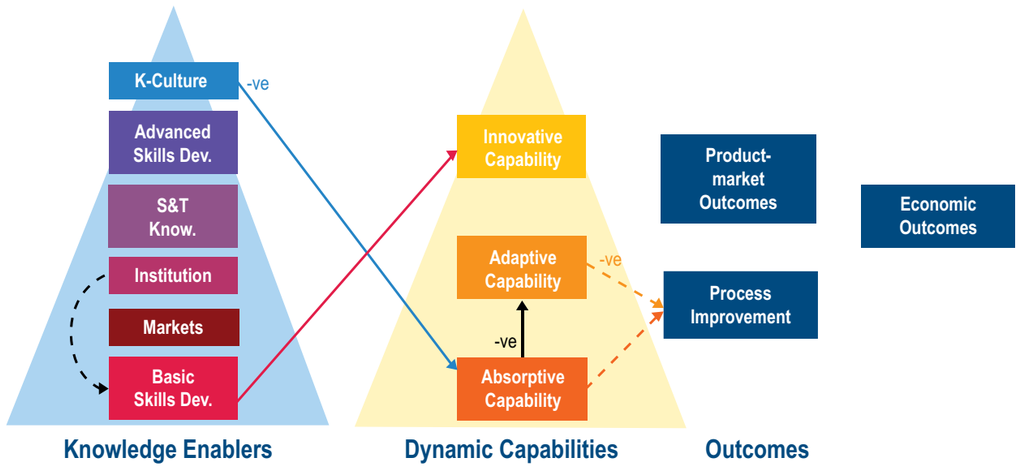


Figure 16.6: Knowledge Ecosystem for Retail Large vs Retail Micro-SME



Advanced skills development among retailers in Malaysia contributes significantly to absorptive and innovative capability, but not adaptive capability, as per those at advanced economies. This suggests that retailers in Malaysia are active in upgrading employees' advanced skills (such as sophisticated and specialized e-commerce, branding and marketing in retail, etc.). Results also demonstrate that knowledge culture contributes significantly in building dynamic capabilities among retailers in Malaysia. Similar to the wholesale industry, knowledge sharing and learning features strongly as part of the organization culture of retailers.

Finally, consistent with retailers from advanced economies, innovative capability has a very strong impact on innovative products/services among retailers in Malaysia. Compared to wholesalers (who tend to be much larger in scale and complicated structure), retailers are highly flexible and carry lower risk in exploring and adopting innovative services.

The retail ecosystem was compared for large and micro-SME firms and the results of the multi-group analysis are presented in Figure 16.6. The results show that the relationship between basic skills development and innovative capability is significantly stronger among large retailers than small retailers. In addition, impact of institutions on basic skills development is significantly higher among large retailer as compared to small retailers. This suggests that large retailers utilize institutions, such as associations and government agencies in developing basic skills of their retail staff. In contrast, small retailers have very few employees (often the business owners' immediate family members). Also, individuals working in small retail stores typically gain experience through on-the-job training (from experienced staff or the owner himself/herself). Formal training in basic skills is not common among small retailers.

Knowledge culture among small retailers contributes more significantly to absorptive capability than large retailers. With a small team of employees in small retailers, all employees are typically expected to learn all functions of the retail business. A learning and knowledge sharing culture is important in building "well-rounded" employees in small retail business. The results also demonstrate that absorptive capability contributes significantly to adaptive capability of small retailers, and thereby improves the efficiency of retail operation. This suggests that small retailers are able to adopt new knowledge and use it to improve existing processes, such as inventory management more rapidly and effectively than larger retailers.

16.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Retail Industry

Based on the analysis of the knowledge ecosystem of the retail industry, the key strengths and gaps of the ecosystem are provided in this section of the report:

Key Strengths of the Retail Ecosystem:

- Well-developed infrastructure, modern establishments, and some of the largest retail and shopping outlets in South-East Asia open up huge growth prospects for the retail industry.

- Malaysia's growth as a tourist destination bodes well for the future of the retail industry.

- Liberalizing trade and business policies will force a rise in the competitiveness of domestic retailers.

- Local retailers have built strong capabilities over time, as they have long been competing with well-established global brands. With an increasing number of renowned luxury brands opening branches in Malaysia, local players are also beginning to introduce new product lines to cater to more affluent customers. This helps to expand the opportunity for higher value-add retail activity.

Key Gaps of the Retail Ecosystem:

- Large retailers in Malaysia have attempted to build innovative capability by actively engaging in basic skills training and development. This is a worrying trend since basic skills contribute little and only indirectly to firms' innovative capability. Retailers need to rely on higher level skills in building their innovative capabilities.

- Market intelligence does not significantly contribute in building higher level dynamic capabilities (adaptive and innovative) of the Malaysian retail industry. Malaysian retailers need to look beyond superficial trends, to discover long term opportunities and disruptive ideas emerging on the horizon.

- Similar to the wholesale industry, frequent changes and ambiguity in new policies and regulations present great challenge to retailers. This form of stress affects their daily operations. Instead of playing a supporting role, institutions appear to act as constraints in the retail industry. Key institutions such as vocational colleges and higher education institutions need to make stronger efforts to develop human resources equipped with specialized retail skills (such as e-commerce, retail management, and IT based retail operation). These skills are highly sought after in the retail industry.

- S&T knowledge among retailers in Malaysia is far behind most advanced economies. This is critical in the implementation of innovative business models, such as omnichannel retail and cashless retail.

- Despite new knowledge and information, retailers in Malaysia fail to effectively adopt, utilize and implement new information and knowledge in the organization because of a non-systematic approach to sharing and internalizing knowledge.

- Dynamic capabilities within the retail industry are not built systematically. Often a poorly thought through leap-frog approach is adopted, which can lead to waste of resources as a consequence of weak internalization. This leads to poor innovative outcomes.

16.4 Recommendations to Improve the Malaysian Retail Knowledge Ecosystem

Despite major shortcomings in innovation, the retail industry remains an important contributor to the Malaysia's economy and is an important employer. To ensure the sustainability and continued development of the Malaysian retail industry, the following recommendations are proposed to strengthen the knowledge ecosystem of the industry.

Recommendation 16.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Retail Industry

The global retail industry is increasingly governed by standards and best practices on retail operation such as GS1 Retail Standards, Retail Technology Standards, etc. To remain competitive, the Malaysian retail industry should benchmark the global retail standards and best practices, and take measures to implement them.

- ❑ Develop infrastructure to promote and protect local retailers while opening the market for foreign retailers for healthy and vigorous development of the industry to attain international standards.
- ❑ Based on global retail standards and best practices, industry players should come together to identify and establish protocols of practices and standards that define retail practices in Malaysia. The Retailer association should play a leading role in developing standards and best practices.

Best Practice: ***Case-Study 16.1 – Independent Retail Europe.***

Recommendation 16.2: Enhance the Knowledge Institutional System of the Retail Industry

Coordination and collaboration between trade associations (such as Chinese Chamber of Commerce Retail Section), government agencies, and universities is important to establish a knowledge institutional system, thereby driving change in retail industry. A number of activities can facilitate this, including the following:

- ❑ Bring together expertise from relevant institutes, associations and consultants into a single location where retailers can access higher continuing education, share deeper insights and experiences.

- ❑ Systematic civic planning and infrastructure planning to facilitate growth and establishments of shopping malls, hypermarkets and retail shops and business centres for continuous growth of the industry.

- ❑ Build technological infrastructure to support the industry's move towards ICT, including adhering to competitive international standards for seamless transactions.

- ❑ Retail association and government agencies (such as Matrade) should come together to develop platforms for firms to showcase their products and R&D development to the local and foreign market through EXPOs, exhibitions, fairs and roadshows. The platforms must be manned by individuals with high expertise, depth of knowledge and marketing skills to promote Malaysian products and services.

Best Practice: ***Case-Study 16.2 – Global Retail Marketing Association (GRMA).***

Recommendation 16.3: Incorporate an Innovative Knowledge Approach within the Retail Industry

Strong collaboration between industry, universities, associations and government agencies is important to establish innovative and efficient retail services that contribute to development of retail and complementary industries. Actions to take to facilitate this include:

- ❑ Equip the industry with the necessary technological sophistication to facilitate the transition to a "cashless society."

- ❑ Transition to digital formats to ensure customers can execute their transactions through multiple formats (e.gm-transactions).

- ❑ Use technology to create customer touch points and feedback. Use data analytics to better understand shopper behaviour.

- ❑ Promote adoption of technology in retail operation such as RFID (Radio-Frequency Identification) to improve efficiency.

- ❑ Support industry to invest in computer software and other advanced gadgets as part of their strategies. Initiate implementation of an omnichannel retail model.

- Develop high service quality culture in retail firms

- Create strong local brands through the crafting of effective marketing strategies. This will help establish a stronger footing for local firms and SMEs.

- Build a strong team spirit in firms and create a culture of service excellence.

Best Practice: ***Case-Study 16.3 - Creating an Entire Global Online Business: Alibaba Group, China.***

Recommendation 16.4: Develop the Knowledge Capital of the Retail Industry

The retail industry has to work closely with educational institutions to ensure that the courses and programmes that are offered create the range of skills and at a level required by retail industry. The ultimate aim is to develop a competent and professional retail workforce capable of delivering the highest level of service and drive change in the retail sector. Some of the required actions are:

- Provision of training to develop skills that make retail sector ready for IT based environments.

- Skills need to be strengthened in the areas of: inventory management, databases, online purchasing, EDI, as well new selling techniques in emerging media, and RFID technologies.

- Industry and relevant institutions such as associations and higher education institutes must work towards creating a positive outlook within the industry through wage/salary revisions, structured career pathways. This is to attract skilled graduates into the industry.

- Affordable training programs to continuously upgrade the skills set and service levels of the workforce should be in place – this should be jointly conducted with key colleges/universities working in partnership with industry.

- Use training as the starting point for employees to begin the creative process of problem solving and designing novel shopper experiences and formats.

Best Practice: ***Case-Study 16.4 - Retail Academy of Singapore.***

Recommendation 16.5: Develop the Knowledge Competency for the Retail Industry

A comprehensive talent and skills management strategy is important to identify and fill skill gaps in retail industry. Future needs in the areas of visual merchandising, display & Point-of-sale (POS), merchandise analyst, etc. must be mapped out. Collective actions should be taken to ensure that the quality and quantity of these skills are available to meet long term demand.

- Foster strong education institutions-industry collaboration in curriculum design, course development, internships and work placements.

- Foster continuous learning opportunities for SMEs through affordable training programs and courses via universities, colleges, polytechnics, training institutes etc. particularly in areas of ICT, retail operations, etc.

- Tap into the creative potential of staff to problem solve and enhance customer experiences.

- Develop the competency framework for retail workforce and create career path for workers in retail industry. Identify the range of core and specialist competencies needed to realize long term strategies of Malaysian retailers.

Best Practice: ***Case-Study 16.5 - World Union of Wholesale Markets – Retail Sector.***

Recommendation 16.6: Facilitate Knowledge Learning & Transfer within the Retail Industry

Collaboration between industry, universities, associations and government agencies is important to facilitate knowledge learning and transfer that contribute to strategic development of the retail industry.

- Industry associations need to take the lead to systematically collect, analyse and utilize data in helping the industry to make business decisions.

- Establish a strong industry network with shared collective vision of overall development so as to enable set-up of shared facility or centres to support firms in particular areas and other specialized needs within the supply chain.

Best Practice: ***Case-Study 16.6 – Informatisation of the Korean Economy.***

Recommendation 16.7: Strengthen the Knowledge Leverage within the Retail Industry

Stakeholders of retail and complementary industries must work in partnership to facilitate knowledge leverage, and thereby ensure the future success of the industry. Centralized information centres have a key mechanism to strengthen knowledge leverage in the retail industry.

- Create teams full of service excellence leaders, who are the touch point for top class shopper experiences.

- Retail association may take up the role of 'One-Stop Centre' for the retailer community in Malaysia. For example, they could develop a digital portal which contain up to date information on a range of information on new products, technology, and global trends should be established

- Identify a number of universities, colleges, polytechnics and training institutes who specialize as knowledge centres for the retail sector and provide support services to firms across the country.

16.5 Conclusion

This chapter analyses and discusses the state of the knowledge ecosystem for the Malaysian retail industry. The analysis highlighted some of the key strengths and gaps in the Malaysian retail knowledge ecosystem. The empirical analysis has identified some of the weaker links in the ecosystem and offer potential reasons for these gaps. In this chapter, we also discuss key policies and strategies to strengthen the knowledge enablers. These suggestions are based on best practices of global advanced retail economies. This is to ensure that the dynamic capability components of the retail industry are raised to higher levels, hence translating into stronger process improvement and product development, strengthening the knowledge content and economic performance of the Malaysian retail industry.

Appendix for Chapter 16

Case-Study 16.1 – Independent Retail Europe.

A retail group characterized by the provision of a support network to independent SME retail entrepreneurs, joint purchasing of goods and services to attain efficiencies and economies of scale, as well as respect for the independent character of the individual independent retailer.

- Increase the value of members' business, and to improve the economic performance of their shops, as well as actively involve them in the development of the group.

- Respect the independent character of their members whilst ensuring, in various ways, the participation of their members in the direction and management of the group.

- Provide independent retailers with technical and material resources, including all the services and the human capacity required to guarantee the development of flourishing retail businesses: purchasing pools, logistics and IT, training, financial services, consultancy, marketing, shop-fitting and advice on trends, etc.

www.independentretaileurope.eu/

Case-Study 16.2 – Global Retail Marketing Association (GRMA)

A global network for C-level executives from the world's leading retailers. A global education and engagement platform for the retail marketing community.

- Annual leadership forum on retail marketing topics; regional marketing events; online community that facilitate sharing; research reports and case studies on latest development in global retail industry; updated information and knowledge on trends, technologies and omnichannel movements that affects retail industry.

www.thegrma.com/

Case-Study 16.3 – Creating an Entire Global Online Business: Alibaba Group, China.

Alibaba of China, a major global e-commerce company and its various online business facilitation services. Alibaba business model includes consumer-to-consumer, business-to-consumer and business-to-business sales services via its web portals. The portal provides online sales and service to consumers regardless of size of the transactions. It also has a wider reach than most retail stores or portals to customers.

http://www.alibabagroup.com

Case-Study 16.4 - Retail Academy of Singapore.

- Joint effort of Singapore Retailers Association (SRA) and SPRING Singapore, as a platform for the world's leading retail practitioners, academia and owners to come together.
- Programmes not only provide up-to-date knowledge and skills, also include international perspective on the specific areas of retail management through facilitators who are practitioners or subject specialists that have relevant international experiences.
- Key focus is to develop leaders at middle and senior levels of the retail organisation.

www.retailacademy.com.sg/

Case-Study 16.5 - World Union of Wholesale Markets – Retail Sector.

A non-profit association that aims to promote the international exchange of information on wholesale and retail markets. WUWM's goals are:

- To develop and promote the international exchange of information on wholesale and retail markets so as to improve the construction, organisation and administration of member markets;
- To participate in the activities and issues of wholesale and retail markets, as well as production markets or markets at point of origin;
- To exchange experiences, skills, knowledge and expertise for the overall benefit of the membership;
- To develop and promote the important relationship existing between market authorities, operators, traders and businesses on the market.

www.wuwm.org/

Case-Study 16.6 – Informatisation of the Korean Economy.

- Success of countries in ICT and other related areas can be traced back to systematic development and implementation of the national ICT plans. These plans not only emphasize the information economy, but also are prioritising and channelling investment in frontier technology that will help lead not just the ICT industry, but also other industries. A country that has undertaken such development is South Korea. A brief glimpse of South Korea's approach is given below.
  - Key stakeholders (government, industry, trade associations and universities) cooperated to transform the economy from a production based economy to a create economy in five phases:
  - Digitalisation (1987-1994) – digitisation of public administration, world's first 64 DRAM working die, world's first memory device production.
  - Informatisation (1995-2002) – Basic Plan for Informatisation Promotion, comprehensive e-government implementation, world's first commercial CDMA.
  - E-Government (2003-2007) – Basic Plan for u-Korea, construction of high speed information network, worlds fastest high-speed internet service, world's first commercial services of DMB (2005) and WiBro (2006).
  - Integration (2008-2012) – fostering converging technology platforms and applications – 4G LTE, Green energy, Smart Phone, Cloud Computing (VDI).
  - Creative Economy (2013-Present) – Government 3.0, where ICT is used in creative ways in all sectors of the economy, spawning strong new industries (such as software industry, education, creative content, movie industry, broadcasting & communication services, fast and secure internet environment) to create new jobs and address social issues in society.
- The systematic development of the IT strategy has helped other industries raise their global competitiveness. This enabled Korea to become a developed country in a relatively short period of time.

http://eng.nia.or.kr/english/eng_nia.asp

Case-Study 16.7 - National Retail Federation, US

The world's largest retail trade association.

- NRF publishes STORES Magazine, monthly, covering the entire range of interests of NRF members, and LP information Magazine (formerly LP&Security Trends), bi-monthly, covering loss prevention.
- NRF regularly produces sales projections.
- It is the retail industry's voice in conversations about the role of government in business, provide real-time and real-world data about the impact of regulations on retailers and their employees.
- NRF Foundation create opportunities for current and aspiring retail employees to advance education and grow careers.
- Source for industry and consumer data, providing real-time commentary on some of the nation's top economic movements.

https://nrf.com/

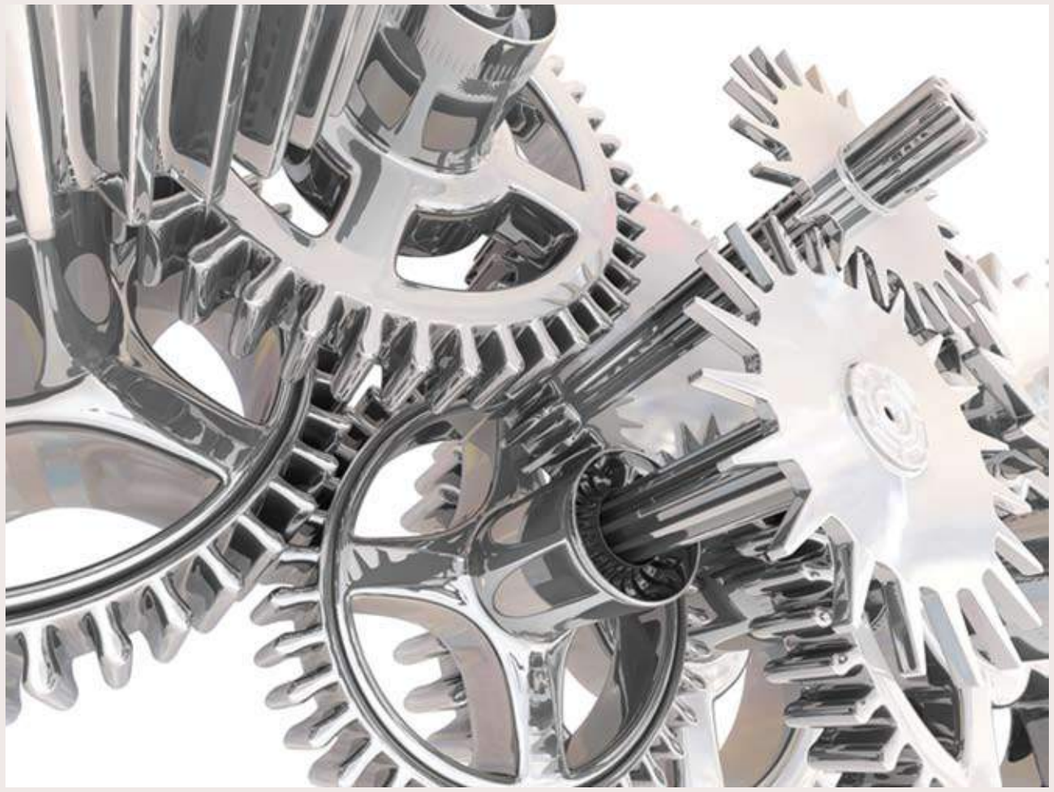
References:

1. Department of Statistics Malaysia. (2015). Sales Value of Goods and Services for Distributive Trade Sector in 2013 Grew by 6.6% Compared to 2008. Retrieved from https://www.statistics.gov.my/index.php?r=column/cthemeByCat&cat=318&bul_id=U1FoUzF2WjBERmgzWHd5elZZVkNWQT09&menu_id=b0pIV1E3RW40VWRTUkZocEhyZ1pLUT09
2. *Economic Transformation Program (ETP) Annual Report 2014 on Wholesale and Retail*, Performance Management and Delivery Unit (PEMANDU), Prime Minister's Office Malaysia
3. http://etp.pemandu.gov.my/annualreport2014/upload/06_NKEA04_ENG_WSR.pdf Accessed on 20 September 2016
4. *The 2016 Global Retail Development Index™: Global Retail Expansion at a Crossroads*, ATKearney
5. https://www.atkearney.com/consumer-products-retail/global-retail-development-index Accessed on 20 September 2016

CHAPTER 17

KNOWLEDGE CONTENT OF THE MALAYSIAN MACHINERY AND INSTRUMENT INDUSTRY

CHAPTER 17
Knowledge Content of the Malaysian Machinery and Instrument Industry



17.0 Introduction

The Machinery and Instrument (M&I) industry is an important pillar for the overall industrial development of a country and is strongly technologically-driven. The M&I industry in Malaysia is identified as one of the sectors that will spur the country into a high technology nation. Over the past decades, the Malaysian M&I industry has embarked on transformative roadmaps to reassess, recalibrate and improve upon existing technological resources. This is to ensure that the industry remains globally competitive amidst the fourth industrial revolution, where increasing convergence between digital platforms and industrial value chains is taking place (German Electrical and Electronic Manufacturers Association [ZVEI], 2015). The M&I industry is classified into four types (Ministry of International Trade and Industry [MITI], 2015): (1) power generating machinery and equipment; (2) metalworking machinery; (3) special-purpose machinery or equipment for specific industry; and (4) general-purpose machinery or equipment, components and parts.

According to Ministry of International Trade and Industry [MITI] (2015), the targeted total exports for M&I industry in the period of 2006 to 2020 is RM494.4 billion, with a 6.4% average annual growth rate. In 2015, products of the M&I industry continued to be Malaysia's top ten major exports, with a value of RM36.1 billion. Despite the conservative growth in global trade, the dampening effects of the slump in commodity exports were mitigated by strong demand for M&I products from developed economies. In particular, as Malaysia's largest regional export partner, exports of M&I products to Singapore rose from RM1.11 billion to RM6.75 billion. This trend continued into 2016 where overall M&I exports from January to September 2016 saw a 10.0% growth of RM2.6 billion to RM28.8 billion from RM26.2 billion over the same period in 2015(MITI,2016).

The government has developed and implemented programs under three Industrial Master Plans to aid and nurture the growth of the M&I industry in Malaysia. This effort is necessary in order for Malaysia to compete on a global scale with the likes of Germany, Japan and China. The cardinal aspect of the Third Industrial Master Plan (IMP3) (2006-2020) was aimed at enhancing Malaysia's global competitiveness through transformations in the manufacturing and services industries respectively.

While many agencies and institutions involved in the development of the M&I industry exist, the major association that represents firms in this industry is the Machinery and Equipment Manufacturers Association of Malaysia (MEMA). MEMA was founded in 1998 as a key enabler for the growth of the M&I industry in Malaysia. It plays a strong role in promoting cooperation among small and medium scale manufacturers of machinery and equipment in Malaysia through information sharing, training and education, research and development, and technology upgrading among its members.

The Malaysian Government also introduced a number of legislations to ensure the sustained development of this industry. These legislations have helped to support the development of the M&I industry. One of the major challenges encountered by this industry is access to qualified workers. As of 2013, 17% of total employment in Malaysia consists of registered foreign workers (Economic Planning Unit, 2015).

The rapid diffusion of the technological era has rendered more demanding requirements in terms of the characteristics of the labour force. Thus, it is imperative for M&I firms to equip their labour force with a high level of broad skills. Even jobs which previously required lower-skilled workers are requiring a certain level of competence in today's dynamic environment to maintain efficient levels of production. In order to overcome potential challenges and to develop the capabilities for innovation from within all levels, training programs and methods need to be more integrated and have become increasingly critical. Thus, to ensure that the quantum and quality of supply of workforce for this industry is high, Malaysia passed the Technologists and Technicians Bill 2014 to set up the Malaysia Board of Technologists (MBOT). The MBOT will assist in the recognition of 30,000 technicians and technologists as professionals by providing educational and vocational training, as well as board registration.[21] Complementing this, four universities established the Malaysia Technical University Network (MTUN), an alliance to produce professional technologist by training the post-secondary and college Technical and Vocational Education and Training (TVET).

To ensure the industry remains globally competitive, the M&I industry must strive to move up the knowledge and innovation value chain. In this chapter, we assess the knowledge ecosystems of the M&I industry using the MYKE-III knowledge ecosystem model for a sample of 102 firms operating in Malaysia. From the sample, 38 are large firms, 64 are SMEs, 65 are local firms and 37 are foreign firms.

[21] According to The Ministry of Science, technology and Innovation (MOSTI), a technologist is defined as a TVET graduate and/or practitioner with a minimum degree in engineering technology and/or a technician with a minimum diploma qualification.

The chapter is organized as follows: in Section 17.1 a description of a knowledge ecosystem of M&I industry in an advanced country is provided. In Section 17.2, we provide a description of the knowledge ecosystem for the Malaysian M&I industry. In Section 17.3 the report discusses the key strengths and gaps in the Malaysian M&I knowledge ecosystem. In Section 17.4, this report supplies key recommendations to improve the knowledge ecosystem of the Malaysian M&I industry are provided before concluding in Section 17.5.

17.1 Knowledge Ecosystem for M&I Industry in an Advanced Country

The knowledge ecosystem of the M&I industry capturing the complex relationships between knowledge enablers, dynamic capabilities and economic outcomes for advanced countries is shown in Figure 17.1. The ecosystem shows that, for advanced countries, the knowledge enablers, the dynamic capability and outcomes are very strong. Thus, the knowledge enablers of the M&I industry ecosystem play a key role in the development of all three components of dynamic capabilities. Firms possessing strong capabilities leverage on this position to create high level of outcomes through process improvements and new product developments which together contribute to economic outcomes.

The high level of development in the knowledge ecosystem for the M&I industry in an advanced country contributes positively to the economy. For continuous sustainability and to remain competitive globally, these economies invest significant resources to enhance its dynamic capability. Hence, the knowledge enablers for the M&I industry in advanced countries are able to contribute to the three components of dynamic capabilities, namely, absorptive, adaptive and innovative capabilities; which drives process improvement and product development which in turn lead to positive economic outcomes. In these countries, the following have been undertaken by the M&I industry shown in Figure 17.1:

- *Alignment of Policies and Strategies to Global Industry Trends, Standards, Regulations and Best Practices (Knowledge Context) of the M&I Industry* – ensure government agencies have in-house experts to provide valuable information and knowledge to put in place a robust certification process. This is to ensure that the M&I industry products are able to penetrate global markets and continuously maintain their global competitiveness by meeting the global standards for sustainability practice. *Best Practice 17.1 - INDUSTRY 4.0: Smart Manufacturing for the Future, Germany*

- *Enhance the Knowledge Institutional System of the M&I industry* –Key collaborations with the various stakeholders and government agencies to provide multi-stakeholder partnerships to enable the industry to develop 'holistic' strategic plans. The strategic plans incorporate an implementation strategy, clearly articulating key performance indicators to be achieved over a specified time period; identify key research focus areas of development and utilize information and communication technologies (ICT) that will lead to new breakthroughs to enable the industry to intensify process improvement and new product development. Refinements to the strategies, policies and milestones were undertaken regularly to ensure the plan meets the objective of transforming the M&I industry into a knowledge-intensive and a globally competitive industry. *Best Practice 17.2 - INDUSTRY 4.0: Smart Manufacturing for the Future, Germany*

- *Incorporate an Innovative Knowledge Approach within the M&I Industry* – a sector that combines the use of highly sophisticated technology and key future technologies which include robotics, electronics and software to foster seamless integration of all production systems and automation. The advanced countries are moving towards decentralization of production that will transform the industry for virtual systems. *Best Practice 17.3 - INDUSTRY 4.0: Smart Manufacturing for the Future, Germany*

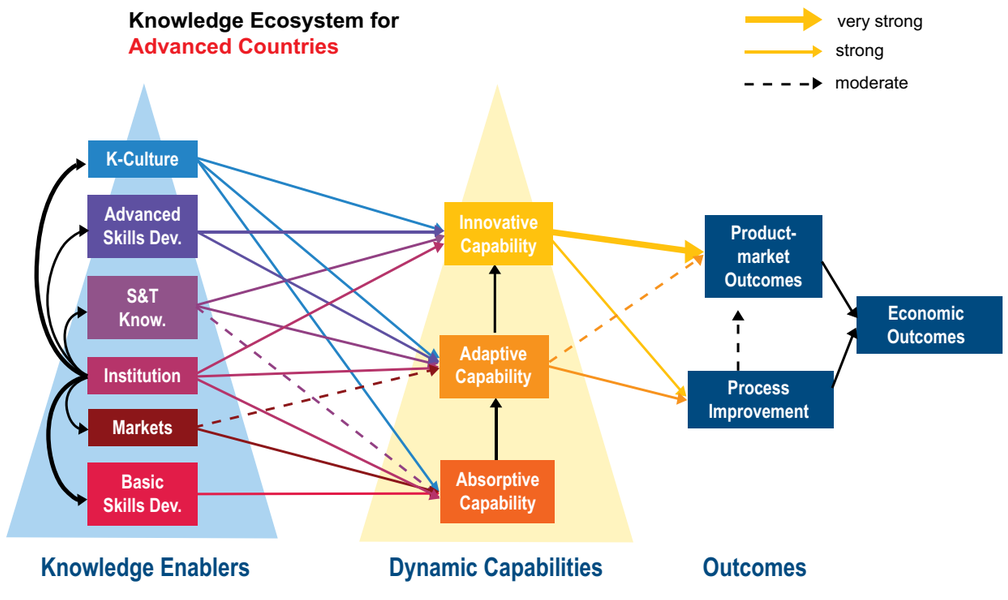
- *Develop the Knowledge Capital of the M&I Industry* – providing a wide range of training programs, workshops and courses to help the workforce to up-skill and continuously improve their skill-set.

- *Develop the Knowledge Competency for the M&I Industry* – a holistic perspective to skills training and continuous upgrading of the workforce with relevant skills sets due to the high impact of technology on new product design. A systematic framework on tracking the rapidly changing landscape of the industry and instituting a review process and upgrading of the competencies are installed. *Best Practice: Case study 17.5- INDUSTRY 4.0: Smart Manufacturing for the Future, Germany*

- *Facilitate Knowledge Learning & Transfer within the M&I Industry* – The strong partnerships between colleges and universities with the industry enables educational institutions to ensure university R&D activities will directly benefit the industry. A sound integrated framework is in place in most advanced countries to develop the key priority areas through S&T and R&D and ensure the spill-over benefits are translated for the industry. B*est Practice 17.6 - Fraunhofer-GesellSchaft, Germany powering translational R&D*

- *The ecosystem has very strong Knowledge Leverage within the M&I Industry* – institutions (government agencies, industry association and educational institutions) play a key role in establishing platforms and forums of exchange of information and knowledge to firms in the industry. *Best Practice 17.7- INDUSTRY 4.0: Smart Manufacturing for the Future, Germany*

Figure 17.1: Knowledge Ecosystem for the M&I Industry in an Advanced Country

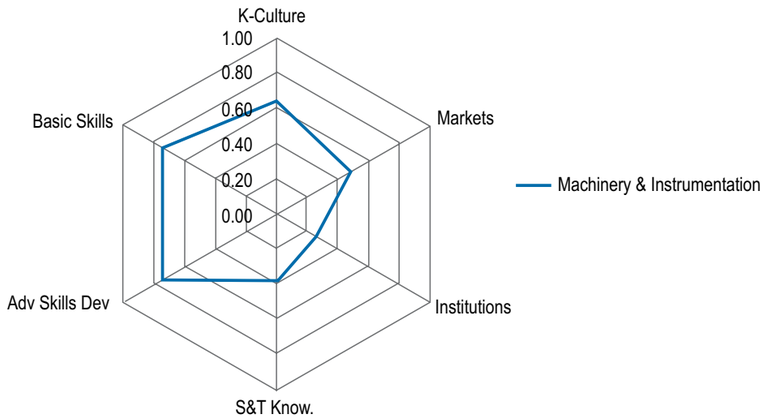


17.2 Knowledge Ecosystem of the Malaysian M&I Industry

In this section, we provide a brief description of the knowledge ecosystem for the Malaysian M&I industry. Figure 17.2 show the state of development of the knowledge enablers. All enablers are performing at a moderate level, with the exception of institutions and S&T, which have scores of 0.26 and 0.48 respectively.

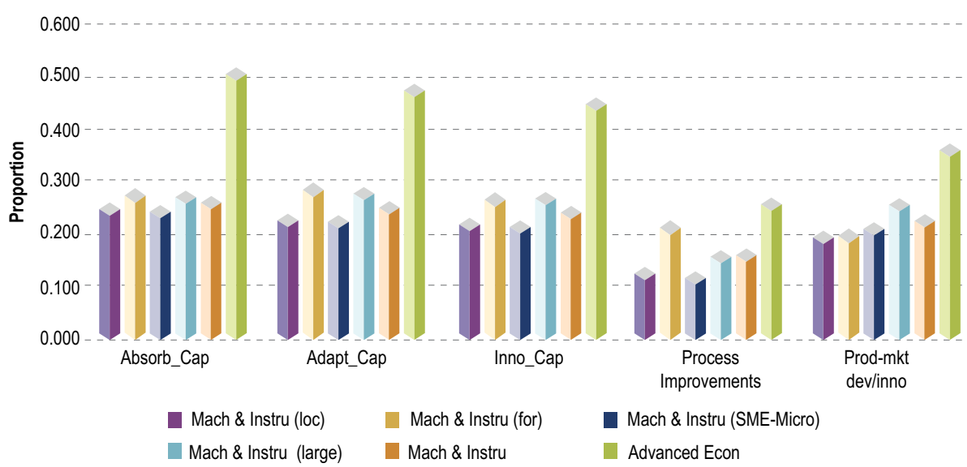
Figure 17.3 show the dynamic capability components, process improvement and product development in the Malaysian M&I and that of a comparable M&I industry from an advanced country. The dynamic capability components, process improvement and product development were measured for large firms, SMEs, local firms and foreign firms. The dynamic capability, process improvement and product development for advanced countries were found to be significantly higher in advanced countries than in the Malaysian M&I industry. Within the Malaysian M&I industry, the performance for foreign firms compared to large firms were found to have only a marginal difference in their dynamic capability and product development with larger firms having a slightly higher process improvement than the foreign firms.

Figure 17.2: Knowledge Enablers for the Malaysian Machinery and Instrument Industry



Note: Values ranging from: 0 to less than 0.5 is weak; 0.5 to 0.7 is moderate and more than 0.7 is strong

Figure 17.3: State of the Dynamic Capabilities of the Malaysian M&I Industry

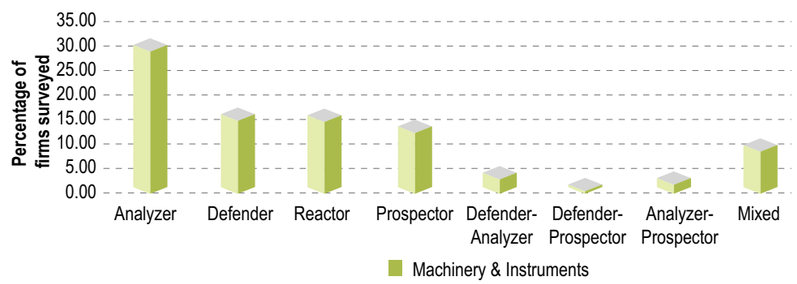


Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

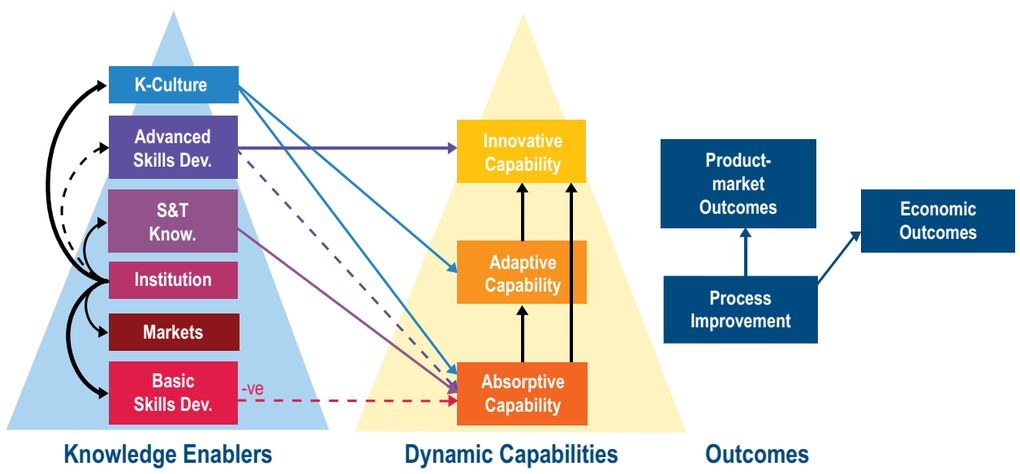
The strategic postures of firms in the Malaysian M&I industry are given in Figure 17.4. As shown in the figure, the M&I industry's strategic profile has a strong presence of firms that are Analyzer (over 31%), followed by Reactor (over 17%) and Defender (over 16%) firms. 14.7% of the firms in the M&I industry are Prospector firms. This suggests that a small proportion of firms in the M&I industry are highly innovative firms that are actively seeking for new markets and new opportunities.

The M&I knowledge ecosystem for Malaysia is shown in Figure 17.5. The Malaysian M&I knowledge system shows that enablers to support dynamic capability components are weaker and unable to create sufficient depth in these capabilities so as to produce strong outcomes compared to the more advanced countries.

Figure 17.4: Strategic Posture of the Firms in the Malaysian M&I Industry



17.5: Knowledge Ecosystem of the Machinery and Instrument Industry



One of the key features of the M&I ecosystem is that institutions play a dominant role in developing the knowledge enablers, but does not influence the dynamic capability of the firms. The knowledge enablers that strongly support absorptive capability are S&T knowledge and knowledge culture.

One of the interesting features that emerges from the empirical analysis is the negative impact of basic skills development on absorptive capability which could be attributed to the heavy reliance on foreign labor. Any training for basic skills does not contribute to the dynamic capability due to the presence of a short-term, transient workforce comprised predominantly of foreign workers.

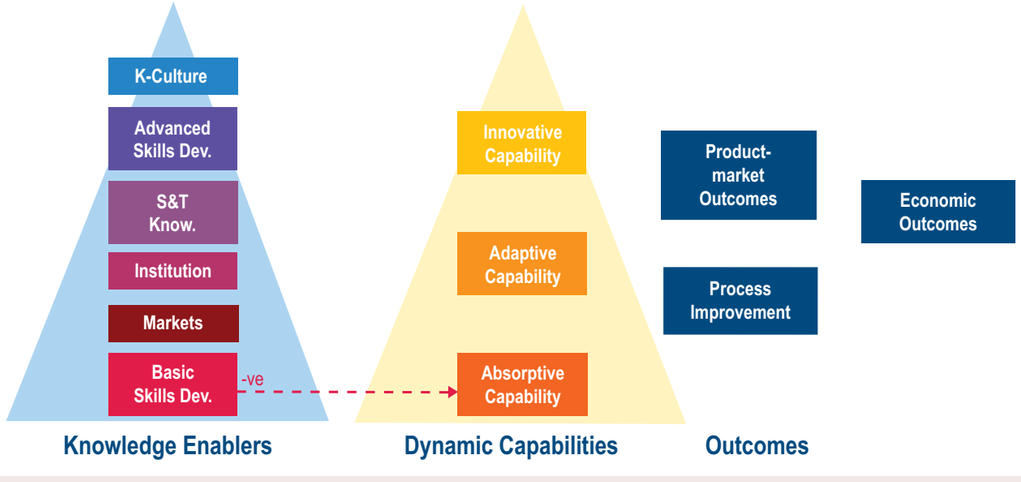
K-culture was found to have a positive impact on absorptive and adaptive capability. As firms build their absorptive and adaptive capability, they develop their innovative capabilities. The analysis also shows that there is a segment of firms in the M&I Industry that try to 'leap-frog' from absorptive to innovative capability.

Given the importance of the M&I Industry to the Malaysian economy, resources have been channelled to key GRIs, universities and large industry players to undertake R&D activities that will enhance process improvement and spur new product development in the M&I Industry. Hence, it is not surprising that advanced skills development has a strong positive impact on innovative capability and a moderate positive impact on absorptive capability of the industry. This is not surprising as Malaysia is moving towards specialized areas with high technology and high value added M&I. However, advanced skills do not have an impact on adaptive capability and this is due to a lack of development and investment in technically competent staff at the middle level of operations in the industry which prevents firms from undertaking modification and refinements of existing knowledge. This explains why firms in the M&I sector are unable to improve their production process.

However, all three dynamic capabilities, the innovative capabilities, adaptive capabilities and absorptive capabilities were found to have no impact on process improvement and new product development. Process improvement has a strong impact on economic outcomes and product market outcome. Process improvement in this industry is attributed to cost reduction that has led to production efficiency and hence has a positive impact on economic outcomes and product market outcomes.

The M&I ecosystem was compared for large and micro-SME firms and the results of the multi-group analysis are presented in Figure 17.6. The results show that only basic skills development was significantly different for these two groups with micro-SMEs having a greater positive impact on absorptive capability than larger firms.

Figure 17.6: Knowledge Ecosystem for Machinery Instrument Large versus Micro-SME



17.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian M&I Industry

Based on the analysis of the knowledge ecosystem of the M&I Industry, the key strengths and gaps of the ecosystem are provided below.

Key Strengths of the M&I Industry Ecosystem:

The M&I Industry is an important industry for the overall development of the industrial development of the country.

- Strong support from the Malaysia government to develop the industry under the three Industrial Master plans and the five-year economic plans as a major revenue earner for the country. Under the 11th Malaysia plan, the industry receives significant support from the government in terms of the following:
  - ❑ Increasing access to financing
  - ❑ Promoting of automation
  - ❑ Increasing compliance to standards
  - ❑ Increasing R&D activities
  - ❑ Infrastructure development,
  - ❑ Collaborative partnerships between SMEs and large companies, and MNCs to assist SMEs in frontier Industries-SME corporation Malaysia (SME Corp.) and MATRADE to oversee this initiative respectively, and
  - ❑ Capability development (basic and research personnel)-Ministry of International Trade and Industry (MITI) to undertake collaboration with other stakeholders to bridge the skills gap.
- The domestic players are able to buy foreign technologies and build upon their capabilities to add value for their products and services.
- Highly skilled and knowledgeable workforce for research and development and ability to provide engineering design services.
- Cost of production is much lower compared to other advanced countries and the industry is moving towards high technology and high value added quality products (http://www.mida.gov.my/home/machinery-and-equipment/posts/).
- Leverage upon core activities (for example R&D, system development system, calibration etc) which caters to specialized market segments, or custom made products for lower costs and faster delivery. (http://www.mida.gov.my/home/machinery-and-equipment/posts/).

Strategic and cost competitive location with well-developed infrastructure connectivity (land, sea and air) and an integrated telecommunication system, Malaysia has attracted foreign investors. Moreover, the government also offers attractive incentives such as tax incentives and reinvestment allowances to encourage investments in this sector.

Key Gaps in the M&I Industry Ecosystem:

The M&I Industry has undergone rapid transformation due to major technological breakthroughs and converging technology platforms. While these changes have opened new opportunities for firms globally that have adopted to these new technological innovations, many Malaysian firms faced challenges to move up the knowledge and innovation value chain. The challenges encountered by the firms are discussed below:

- Heavy reliance of foreign workers due to the nature of the work and environment ('3D' jobs that is dirty, difficult and dangerous) which appears to be a cost, and workforce retention becomes a major issue due to work permit conditions and language barriers. Further cost (explicit and opportunity costs) of skills training is high.
- Significant resources are invested in technical colleges, but training programs and curriculum do not always meet the needs of the dynamic industry, creating a mismatch between supply and demand in skills for the M&I Industry. This results in the shortage of skilled workers and talent. Skills of graduates do not meet the needs of workers in the industry – most of the S&T graduates are good users of foreign S&T and not creators of new innovations. Under-utilization

of S&T due to institutional weaknesses can be attributed to a lack of expertise and inadequate training to continuously upgrade talent and skills. The industry focuses on cost effective workers instead of focusing on the long-term development of S&T knowledge of the workforce.

- There is also a shortage of technically competent staff at the middle level of operations in the industry which prevents firms from undertaking modification and refinements of existing knowledge. This can be attributed to a lack of a proper assessment of core competencies across all segments of the workforce for the M&I industry. Furthermore, the SMEs face major challenges recruiting high calibre workers because the most qualified labour in the workforce prefer working overseas or with MNCs. They also suffer financial constraints to undertake R&D activities. There exists a lack of highly specialized talent and scientific 'know-how' to mentor and develop local talent.

- The institutions do not directly influence the dynamic capability components because the institutions lack the leadership and experts with strong S&T that could spearhead initiatives, improvements and developments to enable the industry to move up the innovation value chain.

- Weak collaboration, interaction and networking among key stakeholders – encouraging a "silo" mentality and culture in the industry. This prevents these institutions from developing a strategic and implementation plan and sign-posting future key areas to enhance knowledge components in this industry.

- There has been adequate investment in R&D. However, the impact of R&D investment in the M&I industry is low as firms are risk-averse when investing in technology and R&D to improve the knowledge management systems and processes.

- Firms are not aware of all the services provided by government agencies and a single portal, where the M&I industry workforce can easily access services on market information, R&D opportunities and other business development services, does not exist.

- Knowledge sharing culture among firms and key institutions in the M&I industry is not pervasive as compared to more advanced countries and this results in the industry's' inability to realize the multiplier effect of R&D and technology investment. Micro-SMEs lack the support for R&D activities, access to expertise, research facilities and many are also not part of the knowledge networks that provide them access to information on new technology, innovation, market intelligence and other resources that enhance their market competitiveness.

17.4 Recommendations to Improve the Malaysian M&I Knowledge Ecosystem

The M&I industry is a key enabler of other industries, especially manufacturing industries, and also a key contributor to the Malaysian economy. To ensure that the industry continues to be sustainable and to further strengthen the competitive position of this industry vis-à-vis industries from more developed countries, the M&I industry knowledge ecosystems should be further strengthened. The following recommendations are proposed to strengthen the knowledge ecosystem and knowledge content of the industry.

Recommendation 17.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) within the M&I Industry.

The global M&I industry is developing at a rapid pace due to technological improvements and innovations over the last decade and this is forcing M&I industries across the globe to align and adhere to global best practices to remain relevant to the global M&I landscape. It is an important source of competitive advantage and non-tariff barrier for many developing countries such as Malaysia. Furthermore, as stronger trade ties are conceived across the globe, competition from advanced sector countries, such as Japan, US, Germany, and more recently, China, has reduced the attractiveness of domestic M&I products. The M&I industry is an important pillar for the manufacturing industry in Malaysia and it is vital to ensure that the M&I products are able to penetrate global markets and continuously maintain their global competitiveness by meeting the global standards for sustainability practice. In this context, to meet global standards and best practices, the following initiatives should be undertaken:

- ❑ Government agencies supply in-house experts to provide valuable information and knowledge to put in place a robust certification process.

- ❑ Significant resources must be channelled to the development of talent, technology, monitoring and surveillance to ensure adherence to global best practices. The standards must be underpinned by sound and the latest technological developments. As such, education and enforcement needs to be intensified in this industry.

Best Practice 17.1 - INDUSTRY 4.0:
Smart Manufacturing for the Future, Germany

Recommendation 17.2: Enhance the Knowledge Institutional System of the M&I Industry

- ❑ Establish a strong institutional alliance consisting of industry, scientific institutions, GRIs, industry associations and government agencies to assist SMEs and start-ups to implement My4.0I initiatives to achieve the following:
  - ■ Create innovative products and solutions to society through the adoption of Industry4.0 type framework and the *Fraunhofer philosophy.*
  - ■ Create new value and business models to develop and provide downstream services.
  - ■ Create common open standards to enable these firms to adopt standards that reduce production management efforts, link up with other major players and respond to market needs rapidly.
  - ■ Work closely with research institutes and universities to develop innovative products and services that meet both local and international standards.
  - ■ Establish institutes and centres that will transfer Industry4.0 Solutions across diverse industries to SMEs.
  - ■ Establish a national agency that becomes an information resource centre and 'help-desk' for firms, workers, entrepreneurs, industry associations, and academic researchers on the implementation of Industry4.0.
- ❑ Government and GLCs to become key users and promoters of domestic technology.
- ❑ Certification approval processes (for example by SIRIM) should be simplified and made business-friendly. Furthermore, the required standards that currently only apply to local products should also apply to foreign products in order to create a level playing field.

Best Practice 17. 2 - INDUSTRY 4.0:
Smart Manufacturing for the Future, Germany

Recommendation 17.3: Incorporate an Innovative Knowledge Approach within the M&I Industry

Knowledge approach is determined by the types of decision leadership's make with regard to innovation. For example, substantial investment must be made in R&D for innovation and also to adopt organizational perspectives that are open to new ideas in an emerging marketplace. Small firms can access R&D through partnerships or linkages with research institutes, such as the Fraunhofer Institute, the Steinbeis approach, or the Open Innovation model, etc.

- ❑ The centres of excellence (CoEs), GRIs and universities in the M&I industry should adopt the "Fraunhofer" philosophy to intensify translational and applied research.

- Establish strong research collaboration between CoEs, GRIs, universities and industry with target outcomes to be achieved, including the following: higher levels of process improvement and product development via technology/knowledge transfer; increase the number of intellectual properties (IPs) and patents; and, creating new revenue sources from management services, workshops trainings and consultancy.

    - Innovation requires firms to be ambidextrous. Often innovation creates pressures within the firm that are contradictory or in opposition to each other. The major challenge is how well the firm balances "explore vs exploit". Many firms in Malaysia focus almost exclusively on a narrow version of exploit (license technology and manufacture at lowest cost). In such approaches, very little innovation (product or process) takes place. Knowledge approach also captures time orientation (short run profit vs long term bets on innovation). Innovation requires developing a risk portfolio that contains both uncertain bets (innovation experiments, such as fundamental frontier research based developments with high pay-offs), middling bets (incremental innovations) and safe bets (exploiting existing markets through minor cosmetic adjustment to meet customer needs). A balanced portfolio creates a balance in the mix between exploitation and exploration activity such that it allows long term competitive advantage and competitiveness. Ambidexterity creates new competencies and gradually weans the industry off older competencies.

Best Practice: Case study 17.3 - INDUSTRY 4.0: Smart Manufacturing for the Future, Germany

Recommendation 17.4: Develop the Knowledge Capital of the M&I Industry

To ensure that firms are able to transition to higher value added activities and innovate sustainably, it requires a holistic approach to skills and talent management. Without the requisite quantum and quality of talent, any effort to move up the higher value-add spectrum is handicapped. A holistic Approach to talent for the needs of the M&I industry requires building a complex mosaic with many components:

- Courses in universities and colleges should include fields that will transform the M&I industry into a high-tech and knowledge-intensive industry supporting My4.0I. These include the following: computer-integrated manufacturing; digital modelling and fabrication; industrial control systems; industrial internet; intelligence maintenance systems; internet of things; machine to machine language; predictive manufacturing; remote monitoring and control (supervisory control and data acquisition); and big data analytics, human-machine interfaces, robotics, augmented reality, artificial intelligence and design, 3D-printing.

- Major refinement in the course curriculum in the TEVT programs in colleges and polytechnics is required to develop quality and quantity of technical workers who are able to be employed in the next generation industrial plants and smart factories.

- Foster strong university-industry collaboration in curriculum design and course development. Further, to ensure the relevance of these programs, these programs must include internships and work placement training. These capability development programs and courses should map clear career pathways within the M&I industry.

- Industry Associations in partnership with colleges and universities should conduct affordable professionally certified and accredited programs to up skill the workforce in the M&I industry. Eg: the collaboration between GMI on ifactory 4.0 Innovation Centre to incorporate training of German industry 4.0 standards for smart moulds, smart maintenance and smart automation cell).

- Careers in the industry need to be promoted through various media, digital platforms and meetings to showcase the opportunities and career paths that can be followed. Exemplar models of success and achievements of people in the industry.

- Ensure that remuneration packages are competitive, and promotion pathways exist to the very top of the ladder for those observed to have passion and dedication.

Best Practice 17.4 - INDUSTRY 4.0: Smart Manufacturing for the Future, Germany

Recommendation 17.5: Develop the Knowledge Competency of the M&I Industry

- Key stakeholders in the industry should work together to focus R&D activities in technologies that will power Malaysia's 4th Industrial Revolution, which includes developing next generation machinery and instrumentation that incorporates Cyber-Physical System and Embedded Systems & Networks. This will include M&I industries that incorporate the following design principles:
    - *Interoperability* – machines and devices that are connected and communicate ubiquitously with devices and people;
    - *Virtualization* - ability to create virtual reality of the physical world with high degree of precision to enable simulations and decision making process;
    - *Technical assistance/Service Orientation*: the ability to collate information from multiple sources and assists informed decision-making, meet the needs of individual customers and solve urgent challenges in a relatively short period of time and enable tasks in difficult and hazardous conditions;
    - Real-time Capability – ability to make instantaneous decisions via communication network, which reduces wastage and downtime of machines; and
    - *Decentralize decisions* - using digital systems to make decision autonomously, quickly and accurately using artificial intelligence methods and other human-machine interface systems.

- Establish leading centres of excellence in key priority areas to enhance R&D activities, jointly with leading firms & research institutes across the globe. This is to ensure that the next generation M&I cluster is core to the remaining 20 industries, in particular automotive, transport equipment, E&E, healthcare and construction industries.

- The courses and training must incorporate Industry 4.0 framework to improve operation efficiency and global competitiveness of the M&I industry.

- Fore-sighting and signposting of the future development of the industry is critical for the correct nurturance of competencies. Universities and colleges need to focus courses in specific fields that will transform the M&I industry into a high-tech and knowledge-intensive industry supporting My4.0I. A holistic talent management strategy that incorporates data analytics to identify mismatch in skillsets in the M&I industry. (Eg. computer-integrated manufacturing; digital modelling and fabrication; industrial control systems; industrial internet; intelligence maintenance systems; internet of things; machine to machine language; predictive manufacturing; remote monitoring and control (supervisory control and data acquisition) and big data analytics, human-machine interfaces, robotics, augmented reality, artificial intelligence and design, 3D-printing).

- Incentivize universities and research institutes to develop specific areas of expertise relevant to current and future needs of the industry. Based on chosen strategic pathway, build or strengthen centres of excellence through high-end research and close links with industry.

- Create U-G-I internships and job rotations to develop the capabilities and awareness of individuals in emerging areas so that they are well prepared for the likely direction of the industry.

Best Practice 17.5 - INDUSTRY 4.0: Smart Manufacturing for the Future, Germany

Recommendation 17.6: Facilitate Knowledge Learning & Transfer within the M&I Industry

Significant effort is made to attract MNCs and foreign firms to Malaysia through a variety of partnership agreements and joint ventures. However, the level of knowledge transfer that takes place is not comparable to the expectation based on the number of JVs and level of FDIs. Knowledge transfer needs to be explicitly managed rather than left to chance.

- Scan the environment and enter JVs or collaborative partnerships with companies with the requisite skills and competencies. Normally K-transfer is most successful within long term partnerships in which strong levels of trust and cooperation are developed.
- Explicitly include in the agreement a clause that focuses upon knowledge transfer, its nature boundary and span. Explicitly stipulate specific K-transfer metrics for measurement and tracking purpose.
- Create win-win partnerships between firms, research institutes, universities, and MNCs.
- Utilize schemes such as Global Incentives for Trading (GIFT) to promote Malaysia as a regional hub for R&D in key identified areas to attract leading anchor firms and joint venture partnerships.
- Common failing of K-transfer is the assumption that partnerships will automatically create an inward K-flow. A partnership and even an explicit clause just sets up the platform for k-transfer to take place. However, specific mechanism must be built in to ensure it does. One successful mechanism is use of a Teaching Company Associate (TCA), in which a well-qualified staff and/or doctoral student is made responsible for k-transfer. Sponsored programs, such as the MyBrain initiative, are highly suitable for this purpose.
- Tracking of k-transfer should be instituted within the process by carefully thought through metrics.

Best Practice 17.6: Fraunhofer-GesellSchaft, Germany powering translational R&D

Recommendation 17.7: Strengthen the Knowledge Leverage within the M&I Industry

The M&I industry is an important contributor to Malaysia's economy and to ensure that the industry plays a key role in the nation's agenda, key institutions (government agencies, industry associations, and universities) should work closely to develop a strategic plan that ensures the M&I industry is developed in a sustainable manner. This would require the following:

- Creating an industry association or federation that has an extensive network of industry members which includes in its membership research institutions, universities that are conducting leading edge research in specified fields, as well as training and development and marketing support services. Pool the Association's resources to create a repository of knowledge (market, technical, frontier research) and support the dissemination of knowledge to members. Such industry associations can be the backbone of industry, charting its development to highly innovative sectors through 'One-Stop Centre' to supply a range of knowledge, advice and support services.
- For example, research institutes and universities often possess specialist labs and equipment as well as staff with the capabilities to run them. Often times these very expensive assets can lie idle. By allowing open access, SMEs can do R&D which would otherwise be prohibitively exorbitant.

- Key research institutes (universities, GRIs and CoEs) can be important 'One-Stop Centre' for firms in the industry. The online portal can also be an important source of information for services such as access to financing, expertise, research infrastructure, new science & technology and discoveries related to the M&I industry.
- Creating translational R&D infrastructure, such as Fraunhofer-GesellSchaft, Germany which provides access to new and innovative technology for companies that otherwise would be unable to afford it. It has 67 research institutes spread across Germany that are focused on different fields of science and technologies according to the needs of the German industry.

Best Practice: 17.7 INDUSTRY 4.0: Smart Manufacturing for the Future, Germany

17.5 Conclusion

This chapter provided valuable insights on the current position of the knowledge ecosystem for the Malaysian M&I industry. The empirical analysis highlighted some of the key strengths and gaps in the knowledge ecosystem. Also, the study also identified the key knowledge enablers that facilitated the industry to be a major player in the global M&I market. The results also highlighted the missing linkages in the ecosystem and provided key reasons for these gaps in the ecosystem. Key policies and strategies are suggested to strengthen the knowledge enablers; so as to ensure that the dynamic capability components of the industry are raised to higher levels to translate into stronger process improvement and product development were discussed, strengthening the knowledge content and economic performance of the industry.

Appendix for Chapter 17

Case study 17.1 - INDUSTRY 4.0: Smart Manufacturing for the Future, Germany

Germany is a global leader in the manufacturing equipment industry and as part of their high-tech strategy 2020 Action Plan and to lead the way towards the new stage of industrialization, the German government initiated Industry4.0. Industry4.0 is a strategic initiative to promote the computerization of manufacturing technologies and autonomous exchange of information which is revolutionizing the manufacturing sector.

The manufacturing and equipment industry in Germany is facing competition from growth in low-wage emerging economies and in a long term can affect the country's competitive advantage. Key challenges that Germany's manufacturing industry is facing include a shortage of human capital due to the aging and declining population, high wages, and decreasing demand from emerging economies and rising prices for resources such as raw materials. To address some of the challenges, the German manufacturing industry has undertaken a focused approach and established a very strong platform for Industry4.0 to ensure that the industry is resilient to competition.

Best Practice 17.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) within the M&I Industry

Germany established a steering group, the DIN/DKE Steering Group Industry 4.0[22], to address the conceptual and operational aspects of matters pertaining to standardization issues in the modern production era. This task force established a comprehensive guide, the "Standardization Roadmap" on Industry 4.0, and is the platform of communication between the various stakeholders which include standardization committees, government agencies, associations and research institutions. The following initiatives were undertaken:

- A common vision and implementation strategy by all institutions have increased the adoption of Industry4.0 among German M&I firms and have addressed the competitiveness of the industry by realigning the strategies to strengthen their ecosystem. Standardization, where relevant standards are drawn on a consensus-based process involving the networking and integration of the various stakeholders through collaborative partnerships is undertaken.

- Significant resources are channelled for the development of talent, technology, monitoring and surveillance to ensure adherence to global best practices. The standards are underpinned by sound and the latest technological developments and their enforcement is intensified in this industry. Government agencies have in-house experts to provide valuable information and knowledge to put in place a robust certification process. The key performance indicators are regularly reviewed and strategies are continuously refined to ensure the industry is at the forefront of development and market leadership

Best Practice 17.2: Enhance the Knowledge Institutional System of the M&I Industry

Germany has an institutional framework that is complementary in nature; the institutions (government agencies, industry, associations, universities and research institutes) work in close partnership and reinforce each other to build knowledge content. The interaction between different institutions is led by similar underlying principles, allowing them to work in tandem to enhance the competitiveness of the industry in a sustainable manner in the modern production era. The German manufacturing industry's success has been attributed to this complementary effect. This is done by regular consultations and developing a 'holistic' strategic plan for the industry and is summarized as follows:

- There is strong institutional alliance consisting of industry, scientific institutions, GRIs, industry associations and government agencies to raise the global competitiveness of the industry through enhancing the productivity of the firms; investing in the right R&D, scientific knowledge and technology to solve the challenges of the industry; investing in the right talent for the industry; and investing in information and knowledge management systems that is the foundation to raising the dynamic capability of the industry.

- Assist SMEs and start-ups by transferring Industry4.0 solutions from across diverse industries to create new value and business models and to develop and provide downstream services.

- Ensure common open standards to enable these firms to adopt standards that reduce production management efforts, link up with other major players and respond to market needs rapidly. Furthermore, sustainable and global best practices and standards pertaining to environment, work quality and overall well-being of society are adhered to.

Best Practice 17.3: Incorporate an Innovative Knowledge Approach within the M&I Industry

Machinery and equipment industry in Germany creates an innovative knowledge culture that combines the use of highly sophisticated technology and key future technologies which include robotics, electronics and software to foster seamless integration of all production systems and automation. The M&I industry also creates a culture to improve the flow of information and knowledge across all stakeholders; increase the value proposition for consumers; holds a pioneering role in improving products using environmental and climate protection technologies, and instils a culture of continuous improvement.

Best Practice 17.4: Develop the Knowledge Capital of the M&I Industry

The industry maintains its high knowledge capital by ensuring that the dual vocational training system and continuing professional development in the industry are adaptable and flexible to keep pace with and respond to technological advancements. An inclusive skills development program with focus on interdisciplinary skills due to greater interaction between human-computer interfaces is in place. This includes a short, basic vocational training course and formal certifications and qualifications for a wide range of workforce in the M&I industry. These courses are jointly designed with industry and is followed by internship, work placement programs and subsequently leading to advanced study programs. Leveraging on the strength in engineering and technology related areas, Industry4.0 is envisaged to help Germany be the leading provider of cyber-physical (Smart) systems by 2020. Further, sufficient funding was allocated to spearhead smart machines and instruments that incorporate embedded systems with links to electronics, communication technology and microsystems technology.

For more information: http://www.din.de/blob/65354/f5252239daa596d8c4d1f24b40e4486d/roadmap-i4-0-e-data.pdf

Best Practice 17.5: Develop the Knowledge Competency of the M&I Industry

The knowledge competency of M&I industry in Germany has a holistic perspective to skills training and continuous upgrading of the workforce with relevant skills sets in response to the technological advances. A systematic framework on tracking the rapidly changing landscape of the industry and instituting a review process and upgrading of the competencies is provided.

[22]DIN/DKE – Roadmap, German Standardization Roadmap, Industry 4.0 Version 2, 2016

Best Practice 17.6: Facilitate Knowledge Learning and Transfer within the M&I Industry

To foster strong translational R&D that benefits the industry, The Fraunhofer-Gesellschaft[23], a research organization was founded. This research organization opens new revenue streams in the form of providing the following services: strategic planning of M&I Industries; consultancies; market studies; development of new processes and technology for industry and the research community in the country. The institute undertakes studies for industry partners on a wide range of studies and analysis such as: custom-designed studies; feasibility and acceptance studies; market and trend analysis; hosts some of the most advanced testing facilities and accredited test laboratories, which is open to firms; on-site training and verification are provided for meeting specified industry standards. The strong partnerships between colleges and universities with the industry enables educational institutions to ensure university R&D activities to directly benefit the industry. A sound integrated framework is in place to develop the key priority areas through S&T and R&D and ensure the spill-over benefits are translated for the industry. For more information: https://www.fraunhofer.de

Best Practice 17.7: Strengthen the Knowledge Leverage within the M&I Industry

The German government focuses on strengthening and empowering entrepreneurs and SMEs with innovation power. To support this, the government has established 5 competence centres[24] to oversee and assist SMEs with the Industry4.0 application by not only creating awareness but also an important resource centre for the M&I community. It also plays an advocacy role involving the various stakeholders for effective dissemination of information relating to technological and organizational matters and providing the essential networks. The Competence Centre is an excellent "one-stop service centre" which can provide services for the M&I community in Germany to acquire information, knowledge, expertise, technology, policy analysis and other resources that will ensure the industry moves up the innovation value chain and continues to be sustainable and globally competitive in modern production. For more information, refer to: Directorate-General for Internal Policies, Policy Department, Economic and Scientific Policy, Industry4.0, Study for the ITRE committee, 2016

[23] The Fraunhofer-Gesellschaft, founded in 1949, is a research organization that conducts applied research and development in the field of natural and engineering sciences that drives economic growth and well-being of society. It is the **largest organization for applied research in Europe and creates translational R&D infrastructure which provides access to new and innovative technology for firms that otherwise would be unaffordable**. It has 66 institutes and research facilities spread across Germany and focused on different fields of science and technologies according to the needs of German industry. There are more than 24,000 staff in 2015 who are majority engineers and scientists with an annual budget of more than 2 billion Euros (2015) generated via contract research. (http://www.research-in-germany.org/en/research-landscape/research-organisations/fraunhofer-gesellschaft.html).

[24] Directorate-General for Internal Policies, Policy Department, Economic and Scientific Policy, Industry4.0, Study for the ITRE committee, 2016

References

1. Ministry of International Trade and Industry [MITI]. (2016). *Major Exports.* Retrieved from http://www.miti.gov.my/index.php/pages/view/3132

2. Economic Planning Unit. (2015). *Strategy Paper.* Retrieved from http://rmk11.epu.gov.my/index.php/en/kertas-strategi

3. German Electrical and Electronic Manufacturers Association [ZVEI]. (2015). *Home.* Retrieved from http://www.zvei.org/En/Pages/default.aspx

4. Malaysia External Trade Development Corporation [MATRADE]. (2006). Third Industrial Master Plan (IMP3) (2006 -2020). Retrieved from http://www.miti.gov.my/index.php/pages/view/1690

5. Ministry of International Trade and Industry [MITI]. (2014). *Machinery & Equipment Industrys*. Retrieved from http://www.miti.gov.my/

6. Ministry of International Trade and Industry [MITI]. (2015). M*achinery & Equipment Industrys.* Retrieved from http://www.miti.gov.my/index.php/pages/view/1782

7. Malaysian Investment Development Authority [MIDA]. (2014). *Malaysia's Machinery & Equipment and Engineering Supporting Industrys.* Retrieved from http://www.mida.gov.my/home/administrator/system_files/modules/photo/uploads/20141111033003_Machinery%20Equipment%20&%20Engineering_Nov2014_.pdf

CHAPTER 18

KNOWLEDGE CONTENT OF THE MALAYSIAN TECHNICAL SERVICES INDUSTRY

CHAPTER 18
Knowledge Content of the Malaysian Technical Services Industry

18.0 Introduction

Malaysia technical services industry plays a key role in pushing the economic development of Malaysia towards its transformation into a high-income and knowledge-based economy. The technical services industry enables other dependent industries to perform at the highest level – the major ones being manufacturing, agriculture, mining and construction. Professional, scientific and technical services such as management consultancy, market research, veterinary, legal, accounting, architecture, engineering, surveying, advertising, and other professional services enable businesses to achieve their objectives and achieve economies of scale. Because of its knowledge-intensive nature, technical service industry offers high value skills and services. Accordingly, the industry drives changes and boosts economic growth of the nation.

Technical services industry has been identified as a focus area in the NKEAs. In particular, 6 entry point projects (EPPs) in aviation maintenance, outsourcing, data centre hubs, green technology industries, pure-play engineering services and shipbuilding and repair have been initiated to boost the technical services industry (Productivity Report 2014/2015, MPC).

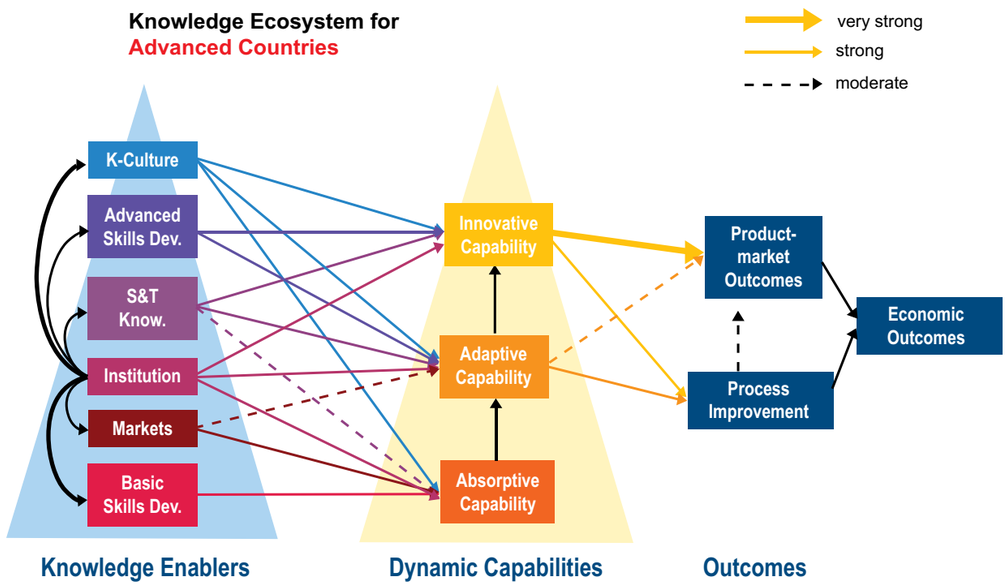
Malaysia's technical services industry is dominated by small and medium sized consulting firms, with some large multinational consultancies and professional services firms, such as the 'Big Four' accounting and business consultancies – Deloitte, Ernst & Young, KPMG, and PwC; and shipping giants – Boustead and Shin Yang. The Government's liberalisation of the services industry in 2009 played a pivotal role in transforming Malaysia into a major regional player in this space, strengthening the industry's competitiveness by attracting foreign direct investment, human capital and technology into Malaysia. According to a report by The Shared Services & Outsourcing Network (SSON), Malaysia has great potential to be the regional hub for business services industry, especially for consolidating finance and accounting operations. The contributing factors for such a favourable position include a multilingual and multicultural Malaysian workforce, an existing and significant shared services presence, an experienced talent pool and proven expertise.

The chapter is organized as follows: In Section 18.1 a description of knowledge ecosystem of technical service Sector in an advanced economy is provided. In Section 18.2, we provide a description of the knowledge ecosystem for the Malaysian technical service industry. In Section 18.3 the report discusses the key strengths and gaps in the Malaysian technical service knowledge ecosystem. In Section 18.4, the report provides key recommendations to improve the knowledge ecosystem of the Malaysian technical service industry before concluding in Section 18.5.

18.1 Knowledge Ecosystem in an Advanced Technical Services Economy

Figure 18.1 demonstrates the relationship between knowledge enablers, dynamic capabilities and economic outcomes for advanced countries. As shown in the figure, knowledge enablers in advanced sector countries appear to be very rich and strong in their nurturance of dynamic capabilities. The technical services industry in advanced countries possesses a strong absorbability capability foundation that feeds into and enriches both adaptive and innovative capabilities. The strength in absorptive, adaptive and innovative capabilities facilitates the development of highly efficient service processes as well as significant levels of improvements in technical services provision. Ripple effects on down-stream industries are created from these outcomes, thereby providing greater support to the national knowledge ecosystem in advanced countries such that the industries in these countries are comprehensively connected for global competitiveness. Key components of the knowledge ecosystem for the technical services sector in advanced countries are discussed in the next section.

Figure 18.1: Complex Relationships in the Technical Services Industry in an Advanced Country



The knowledge ecosystem for the technical services industry in an advanced country exhibits a high level of development and a positive contribution to the economy. Knowledge enablers for the technical services industry in advanced economies are contribute to absorptive, adoptive and innovative capabilities, and thereby drive process improvement and new product development within the industry. All of them contribute collectively to economic outcomes. In other words, the continued investments in knowledge enablers helps in the process of building dynamic capabilities that sustain the development of technical services industry. The following characterize initiatives undertaken by technical services industries in advanced countries:

- *Alignment of Policies and Strategies to Global Industry Trends*, Standards and Best Practices (Knowledge Context) of the technical services Industry. The technical services industry follows closely emerging trends, protocols of practices and standards that define the highest level of service quality and benchmark practices.

- *Knowledge Institutional System works to facilitate development of the technical services industry* – the government in partnership with industry develops a facilitative institutional set-up for the industry and identifies key priority areas of development of the industry. Well-articulated strategy and implementation plans are set in place.

- *An Innovative Knowledge Approach within the technical services Industry* – The technical services industry has increasingly adopted advanced technology to foster seamless integration within its processes to deliver high value technical services. Technology is leveraged on to improve operational efficiencies, develop new products and support services and create new revenue streams.

- *Knowledge Capital of the technical services Industry* – Technical services workforce is highly professionalized through a wide range of training programs and courses. These range from simple training programs to formal qualifications such as diploma, undergraduate, postgraduate and professional qualifications.

- *Knowledge Competency for the technical services Industry* – Skill set needed by the industry is clearly mapped out and there is a framework in place to track the changing landscape of the industry. The framework includes a review process which ensures that competencies are upgraded to meet emerging needs.

- *Knowledge Learning & Transfer within the technical services Industry* – A sound integrated framework is in place in most advanced countries to develop the key priority areas through S&T and R&D and ensures spill-over benefits are translated for the industry.

- *Knowledge Leverage within the technical services Industry* – Institutions (government agencies, industry association and educational institutions) play a key role establishing platforms and forums of exchange of information and knowledge to help firms build strong positions in the marketplace.

Best practice case studies for the above are provided in the appendix.

18.2 Knowledge Ecosystem of the Malaysian Technical Services Industry

In this section, we provide a brief description of the knowledge ecosystem for the Malaysian technical services industry based on survey data. The survey was completed by 264 technical services firms in total, out of which 42 are large firms and 222 are small firms. In terms of country of origin, the majority are local firms (n = 240) and only small number are foreign firms (n = 24). Figure 18.2 shows the state of development of the knowledge enablers. All enablers perform at the moderate level, with the exception of institutions (score below 0.4).

Figure 18.3 shows the dynamic capability components, process improvement and product development in the Malaysian technical services and that of a comparable industry from an advanced country. The dynamic capability components, process improvement and product development were measured for large firms, SMEs, local firms and foreign firms. The dynamic capability, process

Figure 18.2: Knowledge Enablers for the Malaysian Technical Services Industry

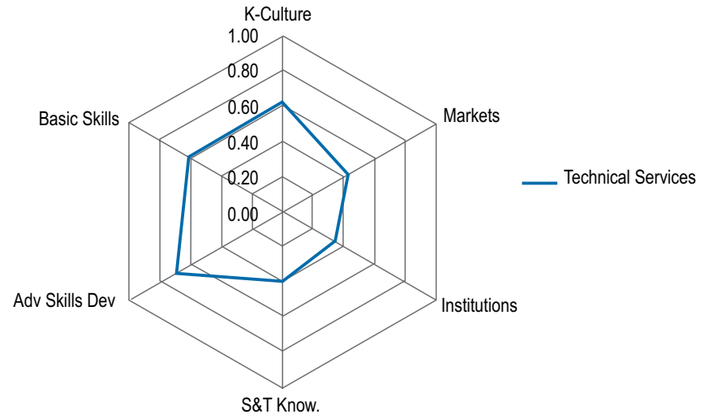
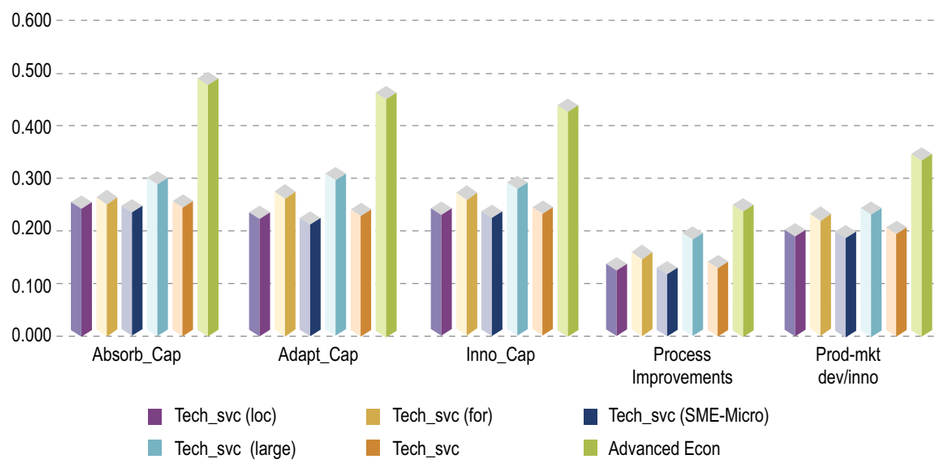


Figure 18.3: State of the Dynamic Capabilities of the Malaysian Technical Services Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

improvement and product development for advanced countries were found to be significantly higher than that of the Malaysian technical services industry. Within the Malaysian technical services industry, foreign firms were found to have higher dynamic capability and product development than local firms. Larger firms also have higher process improvement than SMEs.

The strategic postures of firms in the Malaysian technical services industry is given in Figure 18.4. The figure shows that a majority of firms are Analyser (35%), Defender (over 15%) and Reactors (11%) firms. Only 8% of the firms in the technical services industry are Prospector firms. This suggests that only a small proportion of firms in the technical services industry invest in programs of innovative endeavour.

The knowledge ecosystem for the technical services industry is shown in Figure 18.5. Results show that institutions have a significant impact on all knowledge enablers in the technical services industry. This finding demonstrates that Malaysian government efforts and investment in infrastructure development and various government support and incentives directed towards business services industry have paid off. The technical and professional nature of the industry leads to formation of professional bodies and networks/associations (e.g. The Association of Consulting Engineers Malaysia, Association of Consulting Architects Malaysia, etc) which are in a good position to address the specific knowledge issues of various technical services sub-sectors.

Figure 18.4: Strategic Posture of the Firms in the Malaysian Technical Services Industry

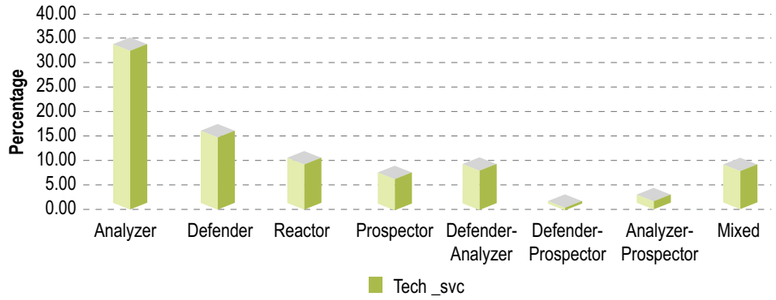
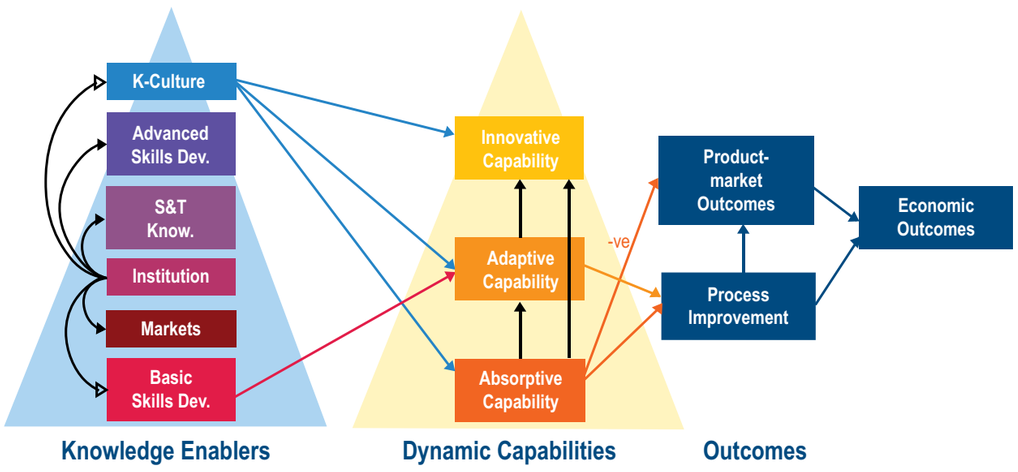


Figure 18.5: Knowledge Ecosystem of the Technical Services Industry



Results also show that basic skills development among technical service providers contributes significantly to adaptive capability building, but not absorptive and innovative capability. Unfortunately, market intelligence, institution, S&T knowledge and advanced skills development all have no impact on any form of dynamic capabilities building among technical service providers. The majority of the technical service providers in Malaysia heavily rely on foreign technology and know-how in their pursuit of creating value for their clients. Often, the adopted technologies are those with wide market acceptability and viability. Local players exhibit a low level of proactivity to engage with activities that facilitate development of knowledge enablers, and thereby have low dynamic capabilities building.

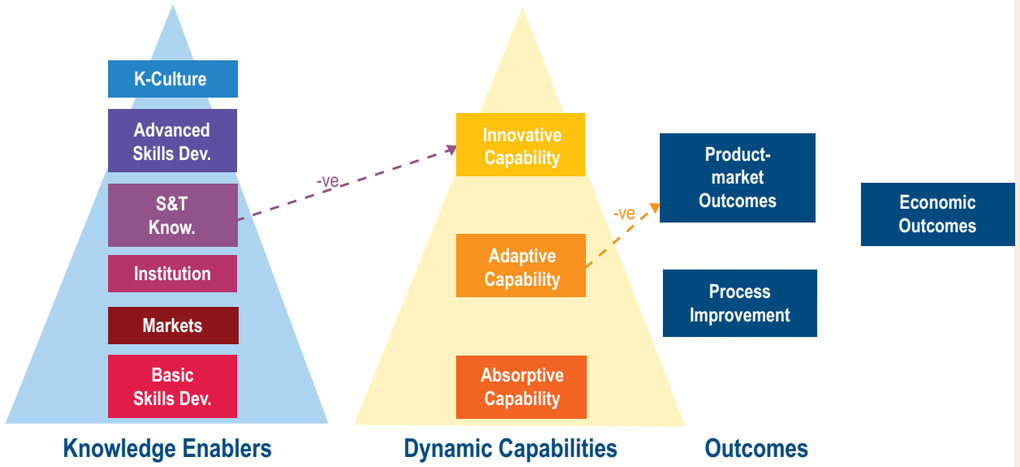
Knowledge culture has a significant impact on building all forms of dynamic capabilities. This suggests that knowledge sharing and learning features strongly as part of the organization culture of Malaysian technical service providers. The technical nature of the industry requires specific and advanced knowledge of a particular domain or specialty. Complex knowledge and experiences gained through the career journey are valuable and transfer of knowledge from senior experts to junior staffs is the norm in the industry. Complex technical projects frequently involve cross-disciplinary team are also a mechanism to share knowledge and create learning culture in the technical service industry.

Consistent with dynamic capabilities building in advanced economies, the absorptive capability of Malaysian technical service providers builds a base for adaptive capability and innovative capability. Results show that absorptive capability contributes to process improvement; however, it has a negative impact on product-market outcomes. Similarly, adaptive capability only has significant impact on process improvement but not product-market outcomes. Finally, innovative capability of technical service providers does not bring about concrete positive outcomes. With heavy reliance on foreign technology and knowledge, local firms mainly focus on modifying and adapting foreign technologies in order to best suit local and regional demands. Such an industry reflex brings about process improvement within the industry, whereby the ultimate aim is to improve cost-efficiency and service quality but not to develop novel solutions. In other words, imitative solutions are provided in a cost-efficient manner.

The technical services ecosystem was compared for large and micro-SME firms and the results of the multi-group analysis are presented in Figure 18.6. The results show that large firms and small firms in Malaysia's technical service industry are only moderately different in two paths. First, surprisingly, the relationship between S&T knowledge and innovative capability is moderately stronger among small firms as compared to large firms. Large firms tend to deal with large scale projects that are expensive and complex in nature, which means that they have little scope to make mistakes. Therefore, the opportunity and ability of their workforce to try out new things by using their S&T knowledge is constrained. This may limit the innovative capability building of the firm as a whole in long run. In contrast, employees in smaller firms may be more flexible to be innovative in offering technical services by using their S&T knowledge, thereby leading to greater innovative capability building.

Second, the impact of adaptive capability on product and service innovative outcome is significantly stronger on small firms as compared to large firms. Similar to the above-mentioned logic, smaller firms may utilize knowledge internalized within the firms to churn out innovative solutions at much lower expense as they tend to deal with smaller scale projects. Accordingly, the potential of creating novel technical service solutions is higher among small technical service providers.

Figure 18.6: Knowledge Ecosystem for Technical Services Large vs Technical Services Micro-SME



18.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Technical Services Industry

Based on the analysis of the knowledge ecosystem of the technical services industry, key strengths and gaps of the ecosystem are provided in this section of the report:

Key Strengths of the Technical Services Ecosystem:

- Pool of multi-lingual, multi-cultural, multi-ethnic workforce. Being exposed to a multi-cultural context since young, the Malaysian workforce is high in cultural intelligence. Multi-language proficiency is another key strength of Malaysian workforce, especially for those working in the technical service sector.

- Strong and multi-pronged government support to feature Malaysia as an attractive business destination for international players. Some of the initiatives include MSC Malaysia's ICT initiatives by MDEC; Digital Malaysia to promote digitally-enabled ecosystem in Malaysia, and Outsource Malaysia to support the outsourcing industry.

- With large pool of graduates trained in accounting/ commerce and business administration-related disciplines, finance and accounting in Malaysia is quite strong as a service industry.

Key Gaps of the Technical Services Ecosystem:

- Fast paced industry that requires constant development to keep pace with rapid changes taking place in client industries, especially technological developments that are constantly changing the competitive landscape of the industry.

- Constant reliance on foreign technology and knowledge within the industry. Local firms often adapt others' technology and knowledge, and over time have become highly dependent on knowledge created elsewhere.

- The skills of graduates do not meet the creative and innovative needs of the industry. Most S&T graduates are adept users of foreign S&T but fail to create new innovations and applications suited to the local and regional industries.

- SMEs have major challenges recruiting high calibre workers. SMEs are not sufficiently focussed on R&D, therefore, well qualified individuals opt to work overseas or with MNCs operating in Malaysia.

- Strong competition within the industry, especially for non-accredited professional services. Most of the non-accredited professional services are SMEs, who expend very little resources on market intelligence or capability development programs for their employees. These firms tend to provide single element services for clients instead of providing end-to-end services.

- Most local SMEs are not competent in using new technologies, such as the Cloud and Big Data Analytics to gauge changes taking place in the industry, especially changes in the underlying structure of the economy, labour market, competitive nature of the industry, and trends in customer preference and needs. Lack of evidence-based information hinders these firms from optimally investing their resources in services that increase their return on investment.

18.4 Recommendations to Improve the Malaysian Technical Services Knowledge Ecosystem

Despite major shortcomings in innovation, the technical services industry remains an important contributor to the Malaysian economy and is an important employer. To ensure sustainability and continued development of the Malaysian technical services industry, the following recommendations are proposed to strengthen the knowledge ecosystem and knowledge content of the industry.

Recommendation 18.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the Technical Services Industry

The Malaysian technical services industry has to respond to increasing demand on high value technical services support. Owing to the technical and complex nature of various technical services, such as oilfield support services, maintenance, repair and overhaul, local industry players should adhere to global standards and best practices in various specific technical fields to ensure productivity and efficiency. Beyond conformance to international standards, members must play an active role in their respective professional bodies in charting the direction of international best practices. Emerging trends and standards of practice, such as Service 4.0 (the services counterpart to Industry 4) must be acknowledged and proactively used to build differentiated positions in high value service provision.

Best Practice: ***Case-Study 18.1 – The Support and Field Services Best Practices Criteria by TSIA (Technology Services Industry Association, USA)***

Recommendation 18.2: Enhance the Knowledge Institutional System of the Technical Services Industry

There should be greater cooperation and collaboration between all institutions (government, industry associations and educational institutions) in mapping out key technical services that are needed by industries in Malaysia and the region.

- A strong partnership between industries relying on the technical services industry has to be formed in order to ensure nurturance of the ecosystem. This requires a strategic alignment of the industries to create space for win-win partnerships to flourish.

Best Practice: ***Case-Study 18.2 – British Computer Society (BCS).***

Recommendation 18.3: Incorporate an Innovative Knowledge Approach within the Technical Services Industry

Malaysian services sectors need to adopt an approach in which innovation and development of new business models for service delivery are developed. This requires substantial resource allocation to innovation activity.

- Government agencies, MNCs and GLCs are encouraged to use local firms for professional technical services for enhancing their productivity and profile in the country and region.

- Key trade organisations, foreign trade offices and embassies should be 'champions' of local technical services in overseas markets.

- The industry should intensify the global engagement of firms through partnerships and engagement with overseas firms.

- Open tender for projects by both the government and private sector to ensure transparency, openness and fair competition.

- Incentives should be provided to local technical service providers to extend their reach in the region.

Best Practice: ***Case-Study 18.3 - Business Services in Germany***

Recommendation 18.4: Develop the Knowledge Capital of the Technical Services Industry

Technical services are heavily reliant on the professional skills and expertise of their workforce in very specific areas. Hence quality of human capital is prerequisite to deliver the highest quality services. Human capital is a core to the ability of firms to succeed in the services sector. It is therefore necessary to have a strategic plan that outlines human capital and skills needs over the long-term horizon.

- Develop skills and capabilities based on future anticipated key developments. Industry fore-sighting needs to dovetail with skill and capability building.

- Collaborate with leading foreign companies to train and equip existing local talent to manage and handle technology and machineries involved in the technical services industry (e.g. short courses, TVETs, certifications in skills and trades etc.). This must be supported by specific technology transfer mechanisms, such as Teaching Company Associates (TCA).

- Career pathways must be carefully devised to allow multiple entry points and progress. This is essential to ensure diverse routes into the industry as well as systematically planned paths for progression.

- Assist and incentivize technical Malaysian talent living abroad to return to the country. Among the incentives proposed to attract those back to Malaysia include the following: provide families permanent residence on arrival; cover relocation cost; and accord recognition to their professional qualifications and experience abroad.

- Joint industry-government funds should be established to develop competitive internships and work-placement scholarships (for newly minted graduates) in key technical and professional services fields where Malaysia has competitive and comparative advantage.

Best Practice: ***Case-Study 18.4 - UK's Professional Business & Service Council (PBSC)***

Recommendation 18.5: Develop the Knowledge Competency for the Technical Services Industry

- Intensify basic (TEVT) and continuous advanced training (leading to certification) that is academically and industrially inclusive through university-industry collaboration (curriculum design, course development, internships, work placements and HRDF programs).

- Establish large scale university-industry research and doctoral courses in the technical services areas (e.g. oilfield support, engineering, etc.) in key research focus areas that will spawn the next generation of the technical industry.

- Access to affordable training programs to continuously upgrade the technical skills set of the workforce should be in place. These programs should be conducted jointly with key colleges/universities in partnerships with industry.

Best Practice: ***Case-Study 18.5 - The Society for Maintenance & Reliability Professionals (SMRP)***

Recommendation 18.6: Facilitate Knowledge Learning & Transfer within the Technical Services Industry

- Industry association, government agencies and universities should organise regular forums and capability development programs for firms in the industry. These forums should cover the latest technology trends, business models, knowledge systems and governance mechanisms that will expand the reach and richness of the services provided by the local players.

- Encourage greater collaboration and networking (such as multidisciplinary teams) among specific technical services providers in the supply chain to enable collective relevance and progress. This can be done by allocating financial resources (grants) and access to state of the art research infrastructure and facilities for industry, government research institutes and universities to undertake leading-edge research and development activities directed to the specific skill and competency needs of technical services industry.

Best Practice: ***Case-Study 18.6 – Young Professionals Network by Association of Consulting Engineering Companies, Canada***

Recommendation 18.7: Strengthen the Knowledge Leverage within the Technical Services Industry

- Establish a "one-stop portal" for technical services listing major players in the key business services industry. The portal should also include information on rules, regulations, incentives and networking opportunities in Malaysia and other countries in the region, especially the ASEAN market.

- Focus on specialization and niche markets. Local industry players should capitalize on niche areas (e.g. oilfield technical support services) in order to build positions of strengths for enhancing competitiveness domestically and in the ASEAN region.

Best Practice: ***Case-Study 18.7 –The Royal Institute of British Architects (RIBA)***

18.5 Conclusion

This chapter analyses and discusses the state of the knowledge ecosystem for the Malaysian technical services industry. The analysis highlighted some of the key strengths and gaps in the Malaysian technical services knowledge ecosystem. The empirical analysis has identified some of the weaker links in the ecosystem and offers potential reasons for these gaps. In this chapter, we also discuss key policies and strategies to strengthen the knowledge enablers. These suggestions are based on the best practices of advanced global technical services economies. This is to ensure that the dynamic capability components of the technical services industry are raised to higher levels, hence translating into stronger process improvement and product development; further, strengthening the knowledge content and economic performance of the Malaysian technical services industry.

Appendix for Chapter 18

Best Practice: Case-Study 18.1 – The Support and Field Services Best Practices Criteria by TSIA (Technology Services Industry Association, USA)

Together with a member-led Industry Standards Board, TSIA developed the Operational Diagnostics and Certification Audits which is a compendium of support operations best practices criteria. The Support and Field Services Best Practices Criteria represents the collective experience of more than 50 leading technology firms. It covers 300 best practices across six separate components of technology service and support – from agent-based and electronic self-service to field service and outsource partner management.

https://www.tsia.com/

Best Practice: Case-Study 18.2 – British Computer Society (BCS)

The British Computer Society (BCS) is the Chartered industry body for IT professionals, the Chartered Engineering Institution for Information Technology and a Chartered Science Institution. BCS is playing an increasingly pivotal role in leading the development and implementation of world class standards for the IT profession through innovative products, services and support. Through its specific "Professionalism in IT" programme, BCS is leading and building IT professionalism up to levels which are currently only seen in more traditional long standing professions such as law, medicine, and accountancy but which will increasingly become the de facto standards for IT professionals.

www.bcs.org/

Best Practice: Case-Study 18.3. Business Services in Germany

Business services industry is an important industry that has been growing rapidly. Germany is one of the biggest contract centre (CC), business process outsourcing and shared service centre (SSC) in Europe. An increasing number of firms are choosing Germany to be their business service provider due to its attractiveness as a location. Germany boasts a highly skilled and motivated workforce, culturally diversity, foreign language skills, excellent infrastructure and high productivity rates.

Germany has led the development of Services 4.0, in which advances arising out IOT and industry 4.0 are helping to revolutionize services production. These developments are shaping the service sector through the development smart service architectures which combine cyber-physical systems, data services and service platforms to define new relationships and new service business models that are transforming existing value chains.

www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Industry-overviews/industry-overview-business-services-en.pdf?v=6

Best Practice: Case-Study 18.4. UK's Professional Business & Service Council (PBSC)

The UK Government through the Professional Business & Service Council (PBSC) formed a business-led Skills Taskforce to address one of the key issues for the development of the UK industry and its future competitiveness: the challenge to ensure that firms have access to an exceptional workforce which allows UK firms to compete to the highest standards in the global marketplace.

The Taskforce in 2014 recorded a number of key achievements, including:

- Achievement of 4,500 apprenticeship starts across the sector between August 2013 and July 2014 and plans in place to target 10,000 Higher Apprenticeship PBS starts by 2018
- Highly encouraging uptake for employer-led Trailblazer initiatives to create new apprenticeship frameworks across the sector. Frameworks for ten major PBS roles are currently in preparation.
- Successful launch of the London Professional Apprenticeship, an enhanced regional scheme to combine apprenticeships with additional training and mentoring
- Launch of Access Accountancy, aiming to reduce the barriers faced by underprivileged young people to entering PBS industries
- Strong support for Professions Week and its efforts to highlight careers opportunities in the PBS sector

http://www.pwc.co.uk/industries/government-public-sector/insights/professional-business-service-council-skills-taskforce-2014-report.html

Best Practice: Case-Study 18.5 - The Society for Maintenance & Reliability Professionals (SMRP)

The Society for Maintenance & Reliability Professionals (SMRP) is a non-profit professional network formed by practitioners to develop and promote excellence in maintenance, reliability and physical asset management while creating leaders in the profession. SMRP provides American National Standards Institute (ANSI)-accredited certification programs to validate and certify certifying the knowledge, skills and abilities of maintenance and reliability professionals and technicians:

- The Certified Maintenance & Reliability Professional (CMRP) program
- The Certified Maintenance & Reliability Technician (CMRT) program

http://www.smrp.org

Best Practice: Case-Study 18.6 – Young Professionals Network (YPN) by Association of Consulting Engineering Companies, Canada

The Association of Consulting Engineering Companies (ACEC) represents the commercial interests of businesses that provide professional engineering services, to both the public and the private sector. The members' services include planning, designing and implementing all types of engineering projects, and providing independent advice and expertise in a wide range of engineering-related fields.

YPN: A Pan-Canadian Network is set up to unite and strengthen the YP network across Canada by promoting best practices and leadership while also creating a network of cross-disciplined and diverse engineers who will be the future leaders of the Canadian consulting engineering industry. Young Professionals are encouraged to partake in various industry task forces, international initiatives with International Federation of consulting Engineers (FIDIC), the annual (Association of Consulting Engineering Companies) ACEC national leadership conferences, social events, site tours and panels.

http://www.acec.ca/about_acec/YPN.html

Best Practice: Case-Study 18.7 –The Royal Institute of British Architects (RIBA)

RIBA champions better buildings, communities and the environment through architecture and its members. They provide the standards, training, support and recognition that put their members - in the UK and overseas - at the peak of their profession. It serves as the "one-stop-shop" of its Architect members; initiatives taken by RIBA include but are not limited to:

- *RIBA library* – collection of four million items, regarded as one of the top architectural collections in the world and the finest in Europe.
- *Research & Innovation* – develop and apply the research-based knowledge of RIBA members, chartered practices and schools of architecture in order to promote links between practice and academia, thereby positioning RIBA as a trusted research facilitator for architecture and the related built environment professions.
- *Business benchmarking* – A compulsory survey for all RIBA Chartered Practices. It provides vital business knowledge about how each member's practice compares to others like it across a broad spectrum of criteria
- *Professional standards* – RIBA operates a Code of Conduct which aims to maintain the highest professional standards amongst their members.

https://www.architecture.com/Explore/Home.aspx

References

1. The Shared Services & Outsourcing Network (SSON) (2015). Malaysia's shared services industry: SSON Market Update 2015. Retrieved from http://www.gbs-iskandar.my/CMSPages/GetFile.aspx?guid=5c0a11a8-ffb3-413e-b1d1-c2e4a79a260f Accessed on 24 November 2016
2. *Productivity Report 2014/2015*, Malaysia Productivity Corporation (MPC), Retrieved from http://www.mpc.gov.my/wp-content/uploads/2016/04/Productivity-Report-201415.pdf Accessed on 20 November 2016

CHAPTER 19

KNOWLEDGE CONTENT OF THE MALAYSIAN BUSINESS DEVELOPMENT SERVICES INDUSTRY

CHAPTER 19
Knowledge Content of the Malaysian Business Development Services Industry

19.0 Introduction

Business development service is an important complementary industry that support and facilitate growth of many other industries. While businesses strive and struggle to be competitive in their core business, they often lack resources to develop important administrative and support processes. Weak administrative and support processes may be the constraint of businesses in building their dynamic capabilities, and thereby hold back their future development and success. Businesses rely on various business development services such as rental/leasing, employment, security/investigation, services to building/landscape activities and office administrative/business support activities to improve efficiency and reduce costs within defined parts of their businesses.

In particular, shared services and the outsourcing (SSO) industry is booming in Malaysia. According to MSC Malaysia, pool of the competent workforce as well as the existing large number of players who have long been competing within the industry had established the ecosystem to facilitate continuous growth and expansion of the industry. With active presence of global big players (e.g. IBM, DHL and DKSH) within the industry, local players have the opportunity to be exposed to international best-practices and standards. Also, employment opportunities within global players enable the transfer of important skills and competencies to the local workforce.

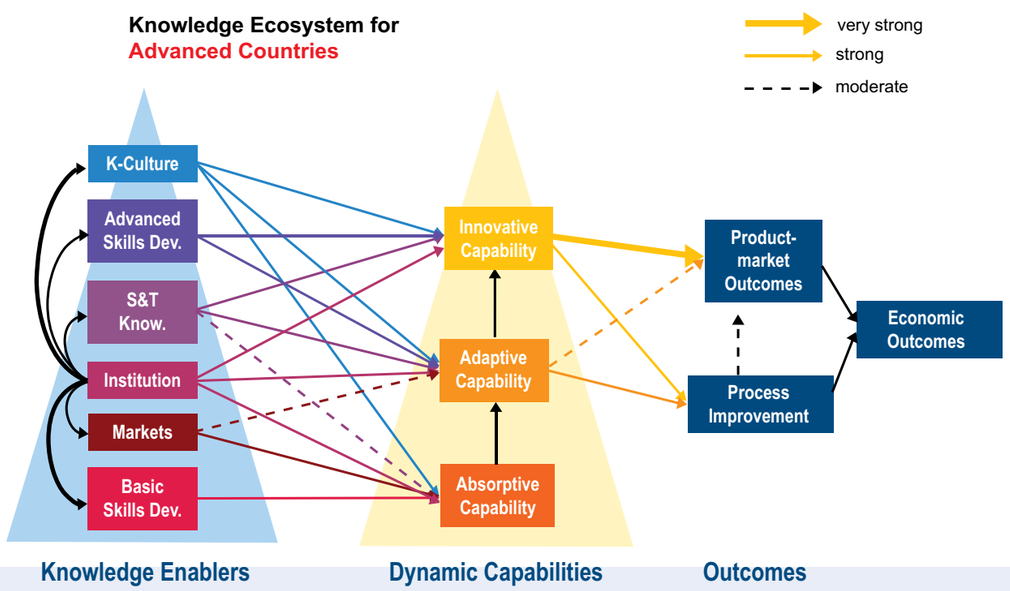
According to AT Kearney's Global Services Location Index, which measures financial attractiveness, people skills and availability, and business environment of nations, Malaysia consistently ranks in third place (behind India and China). With strong support and numerous government incentives, it is evident that the Malaysian government is committed to position the country as a high-value services provider/destination. In 2013, global services analyst Everest Group recognized Malaysia as the "emerging Asian tiger" for Global Shared Services.

The chapter is organized as follows: In Section 19.1 a description of knowledge ecosystem of business development services sector in an advanced economy is provided. In Section 19.2, we provide a description of the knowledge ecosystem for the Malaysian business development services industry. In Section 19.3, the report discusses the key strengths and gaps in the Malaysian business development services knowledge ecosystem. In Section 19.4, the report supplies key recommendations to improve the knowledge ecosystem of the Malaysian business development services industry before concluding in Section 19.5.

19.1 Knowledge Ecosystem in an Advanced Business Development Services Economy

Figure 19.1 demonstrates the relationship between knowledge enablers, dynamic capabilities and economic outcomes for advanced countries. As shown in the figure, knowledge enablers for all three components of the dynamic capability feature strongly in advanced business development services. Institutions (government agencies, trade associations and universities) in advanced countries have a dual role of ensuring other enablers are strong enough to support the dynamic capability components as well as directly influencing their development. Key

Figure 19.1: Complex Relationships in the Business Development Services Industry in an Advanced Country



components of the knowledge ecosystem for the business development services sector in advanced countries are discussed in the next section.

The knowledge ecosystem for the business development services industry in an advanced country exhibits a high level of development and positive contribution to the economy. Knowledge enablers for the business development services industry in advanced economies contribute to absorptive, adoptive and innovative capabilities, and thereby drive process improvement and new product development within the industry. All of them contribute to economic outcomes collectively. Continued investments in knowledge enablers help in the process of building dynamic capabilities that sustain the development of business development services industry. The following characterize initiatives undertaken by the business development services industry in advanced countries:

- *Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context) of the business development services Industry.* The business development services industry closely follows emerging trends, protocols of practice and standards that define benchmark business service practices.

- *Knowledge Institutional System works to facilitate development of the business development services industry* – Government in partnership develop a facilitative institutional set-up for the industry, identify key priority areas of development and define a clear execution plan for strategy implementation.

- *An Innovative Knowledge Approach within the business development services Industry* – The business development services industry has increasingly adopted advanced technology to foster the seamless integration of all processes within the business development services value chain. This helps translate R&D, improve operational efficiencies, develop new products and support services; and create new revenue streams.

- *Knowledge Capital of the business development services Industry* – The business development services workforce is professionalized by having a wide range of training programs and courses. These ranges from non-award certification training programs to formal qualifications such as diploma, undergraduate, postgraduate and research programs.

- *Knowledge Competency for the business development services Industry* – The skill set needed by the industry is clearly mapped out. Frameworks are in place to track the changing landscape of the industry. The framework plays a vital role in upgrading competencies.

- *Knowledge Learning & Transfer within the business development services Industry* – A sound integrated framework is in place in most advanced countries to develop key priority areas through S&T and R&D, and ensure that the spill-over benefits are translated for industry.

- *Knowledge Leverage within the business development services Industry* – Institutions (government agencies, industry association and educational institutions) play a key role in establishing platforms and forums of exchange of information and knowledge to help firms build strong positions in the marketplace.

Best practice case studies for the above are provided in the appendix.

19.2 Knowledge Ecosystem of the Malaysian Business Development Services Industry

In this section, we provide a brief description of the knowledge ecosystem for the Malaysian business development services industry based on survey data. The survey is constituted by 125 business development services firms in total, out of which 22 are large firms and 103 are small firms. In terms of country of origin, majority are local firms (n = 109) and only small number of responded firms are foreign firms (n = 16). Figure 19.2 shows the state of development of the knowledge enablers. All enablers perform at a moderate level, with the exception of institutions and S&T Knowledge (score below 0.4).

Figure 19.3 shows the dynamic capability components, process improvement and product development in the Malaysian business development services sector and that of a comparable industry from an advanced country. The dynamic capability components, process improvement and product development were measured for large firms, SMEs,

Figure 19.2: Knowledge Enablers for the Malaysian Business Development Services Industry

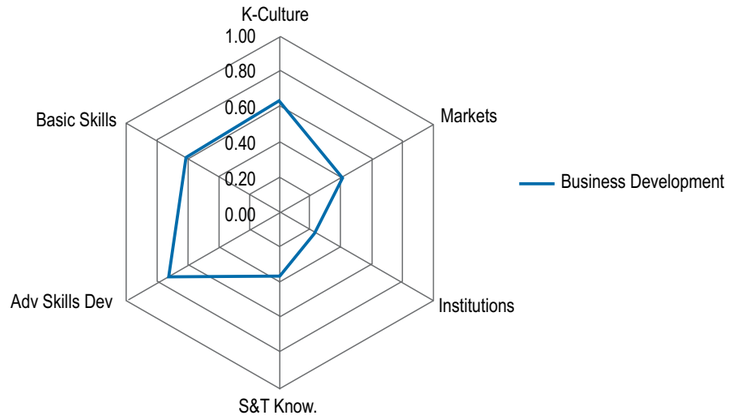
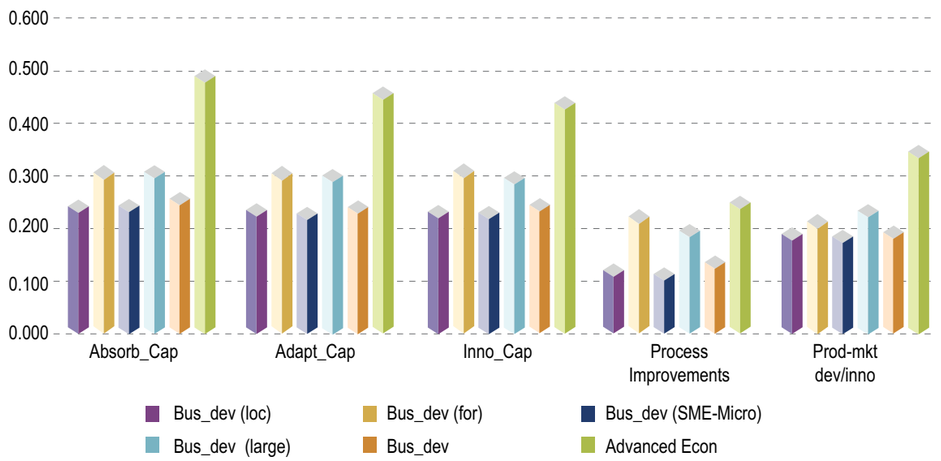


Figure 19.3: State of the Dynamic Capabilities of the Malaysian Business Development Services Industry



Note: The dynamic capability components are productivity adjusted measures for Malaysia and advanced countries

local firms and foreign firms. The dynamic capability, process improvement and product development for advanced countries were found to be significantly higher than that of the Malaysian business development services industry. Within the Malaysian business development services industry, foreign firms were found to have higher dynamic capability and product development than local firms. Larger firms also have higher process improvement than SMEs.

The strategic postures of firms in the Malaysian business development services industry are given in Figure 19.4. The figure shows that a majority of firms are Analyser (close to 40%), followed by Reactor (over 15%) and Defender (15%) firms. Only 6% of the firms in the business development services industry are Prospector firms. This suggests only a small proportion of firms in the business development services industry invest in programs for innovative endeavour.

The knowledge ecosystem for the business development services industry is shown in Figure 19.5. Similar to technical services industry, results show that institutions have a significant impact on all knowledge enablers in the business development services industry. This finding demonstrates that the Malaysia government's effort and investment in infrastructure development and various government support and incentives specifically for business services industry have yielded results. In the business development services industry, basic skills development does not contribute to any form

Figure 19.4: Strategic Posture of the Firms in the Malaysian Business Development Services Industry

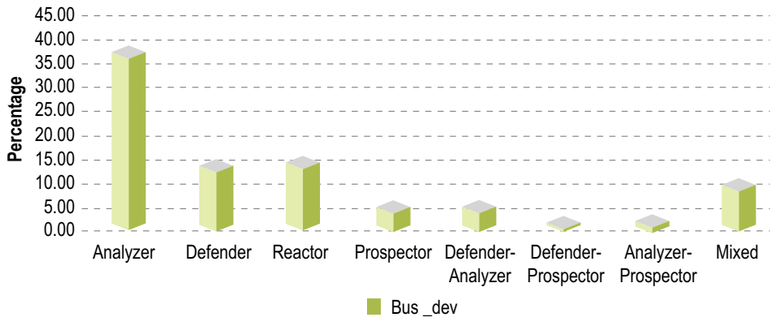
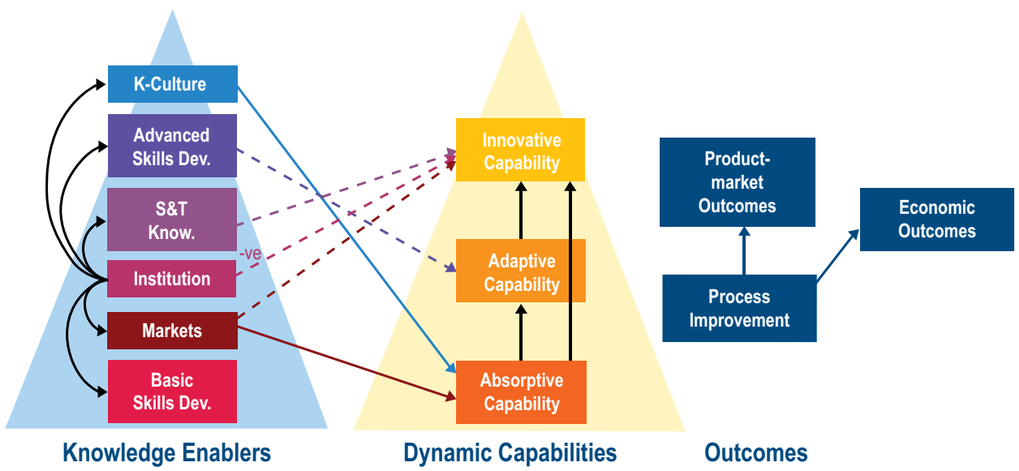


Figure 19.5: Knowledge Ecosystem of the Business Development Services Industry



of dynamic capabilities. High mobility of employees between employers is an industry norm and thus, it seems employers are reluctant to invest heavily in employees' training and development.

Market intelligence contributes moderately to innovative capability building and significantly to absorptive capability building, but not adaptive capability. This suggests that business development service providers actively engaged in learning about upstream and downstream shifts of the industry. However, there is little evidence to show that such the market intelligence is internalized within the firm. Results also show that institutions have negative impact on innovative capability building and no impact on absorptive and adaptive capability building. Higher education institutions in Malaysia are effective in producing a large pool of accounting/commerce and business administration-related graduates. Our finding seems to suggest that these graduates may be competent in executing specified business and operation processes; however, they are not trained to be creators or inventor of new business processes that can drive changes in the business development industry. In other words, Malaysian workforce's mentality is of users or absorbers of routine knowledge, which impedes innovation in the business development service industry in Malaysia.

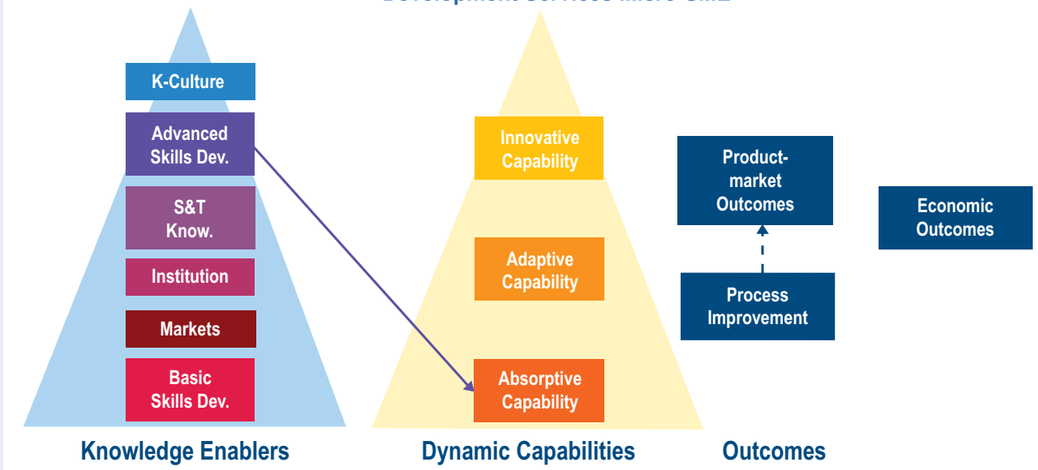
S&T knowledge among business development service providers has a moderate impact on innovative capability building but not absorptive and adaptive capability. This suggests that the workforce in the business development service industry is tech savvy. Competency in computer and technology contributes in building the industry's innovative capability to a certain level. In addition, advanced skill development has moderate impact on adaptive capability building, but no impact on absorptive and innovative capability. This suggests that investment in advanced skills development, such as skills and competency required for process outsourcing is important in building the capability of firms. Results also show that knowledge culture has a significant impact on building absorptive capability but no impact on adaptive and innovative capability.

Consistent with dynamic capabilities building in advanced economies, the absorptive capability of Malaysian business development service providers builds a base for their adaptive capability and innovative capability subsequently. There is no significant impact on process improvement and product-market outcomes from any form of dynamic capabilities. In other words, dynamic capabilities among Malaysian business development service providers fail to bring about concrete positive outcomes.

The business development services ecosystem was compared for large and micro-SME firms and the results of the multi-group analysis are presented in Figure 19.6. The results show that large firms and small firms in business development services sector are only significantly different in two ways. First, the relationship between advanced skills development and absorptive capability is significantly stronger among large firms than small firms. The high costs involved in advanced skills development may be the key factor that distinguishes the small players from large players; and this further influences their absorptive capability. Large players can engage expert and trainer for specific and advanced knowledge in a particular domain to train their employees at one go and achieve economies of scale. Small players tend not to have the luxury to do so. Furthermore, small players tend to rely on few key employees for all of their service deliveries. These employees often have tight service schedules that limit their availability to develop and upgrade their skills.

Second, process improvement leads to greater product and service innovative outcomes moderately among large firms as compared to small firms. This suggests that process improvement take place within large business development service providers such that they lead to product and service innovation. However, such circumstance is unlikely to take place among the small players. While small players are fighting to survive on a daily basis, they may engage with marginal improvement of their business processes especially driven by cost-cutting. Such marginal process improvements are not likely to bring about strong innovative outcomes in terms of new service/product development.

Figure 19.6: Knowledge Ecosystem for Business Development Services Large vs Business Development Services Micro-SME



19.3 Strengths and Gaps in the Knowledge Ecosystem of the Malaysian Business Development Services Industry

Based on the analysis of the knowledge ecosystem of the business development services industry, the key strengths and gaps of the ecosystem are provided in this section of the report:

Key Strengths of the Business Development Services Ecosystem:

- The appetite for business development services in both domestic and international market remains undiminished. Malaysian players have great opportunities to continue expanding from their existing base of operations.

- The Malaysian government promotes local Business Process Outsourcing (BPOs) through the Entry Point Projects (EPPs) program. Incentives and initiatives are provided to allow smaller local players to flourish. Local firms under the EPPs program are benchmarked against the International Association of Outsourcing Professionals (IAOP).

- With a long history and significant number of existing business development service providers, Malaysian players are experienced and mature in the sector.

Key Gaps of the Business Development Services Ecosystem:

- The industry is fragmented and lacks a long-term plan with clear and tractable KPIs, milestones, regular audits and refinements. This makes it difficult for institutional agencies to engage in effective dialogue and make provisions for its development.

- Skills needed are varied and in short supply making it difficult to meet the diversified demands of client industries.

- Over reliance on foreign talent for shared services, leading clients to go direct and outsource services to neighbouring countries.

- Larger firms are able to invest in the creation of a knowledge base to align to emerging competitive priorities. SMEs and micro firms find this task very difficult with limited R&D budgets and depend on others to develop their knowledge and technology capabilities.

- Firms in the sector exhibit a low disposition to build fundamental knowledge in order to drive the development of their high-value product portfolio. The primary focus is on cost cutting as a basis for market competition.

19.4 Recommendations to Improve the Malaysian Business Development Services Knowledge Ecosystem

Despite major shortcomings in innovation, the business development services industry remains an important contributor to the Malaysia's economy and an important employer. To ensure the sustainability and continued development of the Malaysian business development services industry, the following recommendations are proposed to strengthen the knowledge ecosystem and knowledge content of the industry.

Recommendation 19.1: Alignment of Policies and Strategies to Global Industry Trends, Standards and Best Practices (Knowledge Context of the Business Development Services Industry

Benchmark against global standards and best practices, Malaysian business development services industry should initiate service capability and performance standards. This may serve as a framework for service improvement and guides ongoing development of the industry. Some of the best practices and standards on customer service, talent management and other business support services may be contextualized in order to best align with Malaysian conditions.

- ❑ Create/appoint a dedicated commission tasked with leading service providers toward formal certification and adherence to global best practices, thus ensuring skilled individuals are accorded the appropriate industry recognition, career prospects and move the industry up the global innovation value chain.

Best Practice: ***Case-Study 19.1 – The International Association of Outsourcing Professionals (IAOP)***

Recommendation 19.2: Enhance the Knowledge Institutional System of the Business Development Services Industry

A high level advisory panel should be established consisting of members from the business development services industry, public sector and other industries to effectively foster stronger collaborative endeavours between firms in the business development services industry and the other stakeholder. This forum can be used to examine the needs of the industry and public sector; and ways in which the business development services can value-add to their operations. This will also assist the industry in developing a future strategic plan and implementation mechanisms to map the future direction and areas of focus for the industry.

Best Practice: ***Case-Study 19.2 – German Outsourcing Association***

Recommendation 19.3: Incorporate an Innovative Knowledge Approach within the Business Development Services Industry

Malaysian services sectors need to adopt an approach in which innovation and development of new business models for service delivery are developed. This requires substantial resource allocation to innovation activity. Emerging standards and best practices need to be speedily assimilated and used to develop innovative service solutions through strategic innovation of existing business models. To establish leadership positions, a number of accompanying actions need to be in place, such as those set below:

- ❑ Key trade organisations, foreign trade offices and embassies should be 'champions' of local business development services in overseas markets.

- ❑ Ensure local qualifications are recognised by international professional bodies and governments in other countries. This enables Malaysians with local qualification to undertake professional work in other countries.

- Stronger endorsement for local players is required to allow local firms to establish a stronger competitive footing. For instance, provide rebates for engage local business development services providers.

Best practice: ***Case-Study 19.3 - Canadian Business Services Sector – A Global Leader***

Recommendation 19.4: Develop the Knowledge Capital of the Business Development Services Industry

Business services are heavily reliant on human skills to deliver the highest quality services. Human capital is a therefore a core to the ability of firms to succeed in the services sector. It is therefore necessary to have a strategic plan that outlines human capital and skills needs in the long-term horizon.

Focus on qualifications and trainings embed skill-sets required for the industry such as:

- Ability to work with large data – sound knowledge of data analytics, mathematics, statistics, computational thinking, information systems and cyber security.
- Sound use of social media for business development – good knowledge on the use of multimedia and social media for developing creative content.
- Good communication skills, both spoken and written in multiple languages.
- Cultural competency – good working knowledge in diverse cultural setting.
- High order skills set – sound critical thinking, business literacy and problem solving.
- Expert knowledge in niche areas such as environmental sustainability, sound understanding of global standards and best practice, including religious based business regulations and standards (halal industry).
- Foster strong 'industry-professional body-university' partnerships through work placement and internships programs. One such best practice is the post degree industrial training called the Financial Sector Talent Enrichment Program (FSTEP) introduced by Bank Negara. Other professions should also introduce similar types of programs to strengthen talent development in the respective fields.

Best Practice: ***Case-Study 19.4 - Talent Management Strategy in the Australian Business Services Industry***

Recommendation 19.5: Develop the Knowledge Competency for the Business Development Services Industry

- The skill set needed by the industry (e.g. digital operations, risk and fraud consulting, big data and analytics consulting) has to be clearly mapped out. There should be a framework in place to track the changing landscape of the industry.
- A comprehensive talent management strategy for business development services industry must be in place to ensure quantum and quality of professional business support personnel are available for the industry.

Best Practice: ***Case-Study 19.5 - Continuing Professional Development (CPD) program by Canadian Association of Management Consultants (CMC-Canada).***

Recommendation 19.6: Facilitate Knowledge Learning & Transfer within the Business Development Services Industry

- Establish a strong industry network and partnership in which learning and capability building can take place.
- Partnership with leading MNCs, to develop key service skills and develop deep insights into market needs and service provision standards.
- Foster continuous learning opportunities for SMEs through affordable training programs and courses in areas of various global standards and best practices.
- Develop the competency framework to professionalize the workforce and create career paths for workers in business development industry.

Best Practice: ***Case-Study 19.6 – HR accredited courses by (Australian Human Resources Institute) AHRI***

Recommendation 19.7: Strengthen the Knowledge Leverage within the Business Development Services Industry

Effective use of knowledge must be made within industries if they are to capitalize on the benefits of new knowledge. This requires a stronger level of sharing to take place among industry players, as well as provisions to access infrastructure and information to allow effective development and use of knowledge.

- Establish a business development "one-stop portal" in specific areas of service provision is required to facilitate stronger level of sharing and knowledge use. The portal should also include information on rules, regulations, incentives and networking opportunities in Malaysia and other countries in the region, especially the ASEAN market.
- Identification of emerging trends and their implication for business development sector needs to be understood, and disseminated to industry players. Local industry players need to use the emerging trend insights to define potential niche areas that provide them with specific positions of advantage to compete domestically, in the ASEAN region and globally.

Best Practice: ***Case-Study 19.7 Best Practices of Canadian Engineering and Architectural Firms***

19.5 Conclusion

This chapter analyses and discusses the state of the knowledge ecosystem for the Malaysian business development service industry. The analysis highlighted some of the key strengths and gaps in the Malaysian business development service knowledge ecosystem. The empirical analysis has identified some of the weaker links in the ecosystem and offer potential reasons for these gaps. In this chapter, we also discuss key policies and strategies to strengthen the knowledge enablers. These suggestions are based on the best practices of global advanced business development service economies. This is to ensure that the dynamic capability components of the business development service industry are raised to higher levels, hence they translate into stronger process improvement and product development, further strengthening the knowledge content and economic performance of the Malaysian business development service industry.

Appendix for Chapter 19

Best Practice: Case - Study 19.1 – The International Association of Outsourcing Professionals (IAOP)

ISOP is the global, standard-setting organization and advocate for the outsourcing profession. With more than 120,000 members and affiliates worldwide, IAOP helps companies increase their outsourcing success rate, improve their outsourcing ROI, and expand the opportunities for outsourcing across their businesses.

IAOP has created a partnership framework for affiliate associations. IAOP Affiliate Associations are professional, industrial and trade associations that operate as part of a global network to promote outsourcing, offshoring, shared services and related management practices, industries and professions.

www.IAOP.org

Best Practice: Case-Study 19.2 – German Outsourcing Association

Outsourcing Verband is the leading industry and knowledge network of BPO, ITO and SSC organizations and professionals in Germany, Austria and Switzerland. Incorporated as a non-profit organization in Germany, its aim is to build and provide independent information and co-operation platform. Through its activities and initiatives, the association helps develop a competitive position for members in becoming national and global service providers.

http://outsourcing-verband.org/.

Best practice: Case-Study 19.3 - Canadian Business Services Sector

The Canadian Business Service sector is one of the global leaders in a number of areas such as human resource management, customer relations management, knowledge process outsourcing, data mining, application development, project management, and business continuity disaster planning support. The business services sector is a major contributor to the Canadian economy, where the professional, scientific and technical services (a sub-component the business service industry) created employment for 820,307 jobs and contributed C$83.5 billion to the economy in 2013 (Invest Canada, 2014). Success of the Canadian Business Services Sector is attributed to a systematic plan to develop the ecosystem in a holistic way, which includes ensuring the following (Invest Canada, 2014):

- State-of-the-art physical infrastructure (road, ports, bridges, commuter rail and other public infrastructure) that supports a vibrant services sector.

- A business and investor-friendly environment that provide transparent, quick and customer-centric services – rated by Economist Intelligence Unit. as the best pace among G-20 countries.

- A strong data protection act in place; and this is important for services such as human resources management, finance and accounting outsourcing.

- High quality workforce in all fields that are critical for the business services industry – most of the institutions of learning are ranked very well in all global university rankings; and these institutions have strong collaborations with industry players in the business services industry.

- The cost structure and tax regime are competitive compared to other G-7 countries. The corporate tax (both the federal and provincial) is 26.3%, which is 12.8 percentage points lower than the USA. This has led to large firms from the US relocate to Canada, creating employment and contributing to the wealth of Canada.

- Canada pursues a pro-trade policy and is party to the North American Free Trade Agreement (NAFTA), Transpacific Partnership Agreement and the Free Trade Agreement with the European Union; all of which open opportunities for Canadian firms to expand their market reach to these vibrant and attractive markets.

- Canada also provides very generous tax exemptions and funding for the business services industry, among them include the following:

  - *Scientific Research and Experimental Development (SR&ED)* scheme, which provides firms tax credits and refunds for any expenditure undertaken for eligible R&D activities in Canada (it covers wages, materials, some overhead and SR&ED contracts).

  - *Industrial Research Assistance Program (IRAP),* supports path-breaking R&D activities and commercialisation of new products and services for SMEs.

  - *Export Development Canada (EDC) and Business Development Bank of Canada (BDC*) provide flexible financing programs for foreign firms that invest in Canada.

Best Practice: Case-Study 19.4 - Talent Management Strategy in the Australian Business Services Industry

The business services industry in Australia is one of the most globally competitive industries. Over the years, the industry has undergone major changes impacted by a number of domestic and global issues. Among the domestic issues include the downturn in mining industry, which saw business services catering to this industry experience a major downturn. Other factors that adversely impacted the industry are the economic contraction in major developed markets and global competition from other countries. To raise the global competitiveness of the Australian business services, concerted efforts by the industry associations and government were undertaken leading to a major overhaul of the talent required to give the industry a competitive edge in the domestic and international market. The Innovation & Business Skills Australia (IBSA) conducts regular surveys to identify changing structure of the economy and labour market needs of industries. Based on the analysis, various policy measures are undertaken to ensure the talent development strategy supports the development and competitiveness of the industry.

The following focus areas were identified to help strengthen the industry (IBSA, 2015; 2014):

- To cater for diverse life-styles, support work life balance and reduce staff turnover, the industry has adopted flexible work arrangements using virtual teams and digital learning platforms.

- The industry has developed a Core Skills Framework for the industry. The attributes articulated in the Core Skills Framework is incorporated in all training programs, university courses and programs. The framework also maps a clear pathway for career development from certificate (lower level qualification) to vocational training; and from vocational training to tertiary qualifications.

- The business services industry works closely with tertiary institutions, colleges and training providers to achieve the following:
  - Instil a high degree of professionalism - good inter-personal skills, multi-cultural competence and be multi-lingual (both spoken and written).

  - Nurture critical and creative thinking, sound business literacy, problem solving skills.

  - Enhance the use of information communication technology (ICT), social networking technology, knowledge management system and data analytical tools for business decision making and training at all levels. The ICT skills competency is integral to the Core Skills Framework.

  - Ensure adequate training and support for niche areas of expertise, such as in engineering, architectural, finance and other related areas.

  - Ensure that adequate training and support is provided for micro and small businesses.

  - There are adequate skills and leadership trainings, mentorship and coaching programs for first-time managers and front-line workers.

- Undertake regular surveys (industry and employee feedback and review) of the training programs and courses to ensure that it meets the manpower needs of a fast-changing industry.

Best Practice: Case-Study 19.5 - Continuing Professional Development (CPD) program by Canadian Association of Management Consultants (CMC-Canada).

The Canadian Association of Management Consultants (CMC-Canada) fosters excellence and integrity in the management consulting profession in Canada. CMC-Canada's Continuing Professional Development (CPD) program was established to provide a reporting process that ensures CMCs maintain their professional capabilities in line with the Association's Uniform Code of Professional Conduct.

- The goal of the program is to provide a process that recognizes the existing continuing professional development that members may be undertaking to meet their functional specialization (e.g. Accounting, Engineering, Systems etc.) while ensuring that their personal development includes professional consulting activities and contribution to the profession itself.

- Guidelines are available to ensure that CMCs are maintaining their professional capabilities and capacity through CPD.

http://www.cmc-canada.ca/cpdpoints

Best Practice: Case-Study 19.6 – HR Accredited Courses by (Australian Human Resources Institute) AHRI

The Australian Human Resources Institute (AHRI) is the national association representing human resource and people management professionals. AHRI sets the professional standard for HR in Australia through HR certification; provides formal education and training services in HR, people management and business skills; produces world-class conferences; and holds seminars and networking opportunities all over Australia. As the professional association for human resources, AHRI is tasked with ensuring HR professionals and people managers have the essential prerequisite skills and knowledge required to work in the HR profession.

- While AHRI offers two HR qualification courses - our nationally accredited BSB41015 Certificate IV in Human Resources, and the AHRI Practising Certification program - course accreditation is the process whereby AHRI reviews, and where appropriate, recognises other VET, undergraduate and postgraduate courses at Australian education institutions.

- Through the accreditation process, AHRI brings research and industry knowledge to human resources curriculum development to ensure alignment to essential HR skills and knowledge. AHRI delegates this responsibility to a National Accreditation Committee (NAC) which has the task of assessing the curriculum content of HR courses for accreditation by AHRI.

https://www.ahri.com.au/education-and-training/ahri-accreditation

Best Practice: Case-Study 19.7 – Canadian Engineering and Architectural Firms

Professional services are an important part of the Canadian economy, and are becoming increasing relevant as it seeks to increase its value-added activities. With this in mind, Industry Canada, Association of Consulting Engineering companies, Canada and Royal Architectural Institute Canada/ IRAC came together to define best practices of Canadian Engineering and Architectural firms to identify:

- Successful strategies
- Strategies for working internationally
- Barriers to growth
- Innovation and technology

The insights from the study help Canadian firms to develop specific strategies to create and leverage their knowledge base to best effect.

www.ic.gc.ca/eic/site/si-is.nsf/eng/Home

References

1. MSC Malaysia. Retrieved from http://www.mscmalaysia.my/gbs Accessed on 25 November 2016
2. Everest Group *(3 December 2013). Malaysia: the Emerging Asian Tiger for Global Shared Services?* http://www.everestgrp.com/2013-12-malaysia-the-emerging-asian-tiger-for-global-shared-services-sherpas-in-blue-shirts-12510.html/ Accessed on 20 November 2016
3. *2016 A.T. Kearney Global Services Location Index*™, ATKearney
4. https://www.atkearney.com/strategic-it/global-services-location-index Accessed on 24 Novemebr 2016

CHAPTER 20

20. Conclusion

MYKE-III (Phase 2) examined the state of development of the knowledge ecosystems for the 8 industries in Malaysia. In particular, the study examined the following industries: Agriculture (Palm oil, Plant crops, Forestry, Fishery, and Livestock); Electronics and Electrical (Components and Final Products); Food processing; Machinery & Instruments; Chemical, Petroleum and Pharmaceuticals; Rubber and Plastics; Wholesale and Retail; and Business Services (Business Development and Technical Services).

The knowledge ecosystems for these industries were assessed using the Knowledge Ecosystem Model presented in Figure 1.2. Based on the analysis of the knowledge ecosystems and the state of the development of the subsectors of the 8 industries mentioned above, thirteen common challenges were identified that cut across all the subsectors mentioned above. Key factors that cause these challenges and their consequences to the Malaysian economy were identified. Measures to address these challenges are also identified in this chapter. This chapter is organised as outlined below. In Section 20.1, underlying patterns in the economic subsectors mentioned above are identified. Here, key challenges and their impact on the industry and the broader economy are identified. In Section 20.2, recommendations to overcome challenges are proposed before the report concludes in Section 20.3.

20.1 Underlying Patterns

In the previous chapters, the state of the knowledge enablers, dynamic capabilities, economic outcomes for the subsectors were identified. Based on the micro-level analysis of the subsectors, thirteen common challenges were identified and they are discussed below.

Challenge 1: Attracting and retaining workers with basic skills and competencies

Inability to attract and retain workers with requisite level and types of basic skills constrains the ability to move to higher value-adding activity and operations (e.g. automated operations, service delivery, etc.).

Cause Factors/Reasons for Issue

Local workforce is not keen to join the sector due to:

- The nature of the sector (e.g. 3Ds, etc.).
- Remuneration is not attractive.
- Lack of career or structured career path and prospects.
- Perceived lack of appeal and prestige associated with career.
- Vocational skills recognition.

Impact/Consequences:

- Shortage in quality and quantum of workers with needed skills.
- Dependence on foreign workers.
- Generational vacuum, with acute shortage of younger generation entering into the industry. The applicable industries no longer constitute a preferred career choice.
- Industry remains labour intensive and lacking the level of sophistication needed to operate in higher end operations.
- Constrains ability to move up value-added activities, such as automated operations, service quality delivery.

The above challenges are strongly featured in the Palm Oil, Machinery & Instruments and Retail & Wholesale industries.

Challenge 2: Weak technical education and training ecosystem

Basic technical education has not kept pace with the changes taking place in the industry and its marketplace, especially relative to the level of basic skills development taking place in advanced countries. This has led to significant weaknesses in the level and type of technical skills needed to compete effectively in international markets.

Cause Factors/Reasons for Issue

- Lacking a long-term perspective of skills needs and development.
- Failure to recognize vocational qualifications and skills.
- Failure by institutions to fully understand the diverse range of technical skills needed to succeed in the industry due to lack of weak understanding of future skills needs.
- Weak investments in skills upgrading.
- Weak interaction, dialogue and alignment between educational institutions, such as TVET colleges, and industry bodies to map out, develop and deliver required skills in a manner that can be readily accessed by firms.
- Overabundance of very low-skilled foreign workers, creating a tendency to substitute quantity for quality of skills.

Impact/Consequences:

- Basic Skills are “outdated”; they are not able to deal with the operational and process skill requirements for the modern competitive landscape.
- Basic skills unable to contribute to effective development of DC.
- Basic skills unable to contribute to innovation (especially improvements of processes) since they outdated.
- Unable to contribute to “value-add” in product improvement or production improvement.

Challenge 3: Mismatch in the skillset available and needs of industry

Training and development fails to develop requisite level and type of competencies needed by the basic skills workforce for them to contribute in the value creation process, in line with changes taking place in the market place, technologies and the competitive landscape.

Cause Factors/Reasons for Issue

- Technical education and skills have not kept pace with market and competitive dynamics, due to failure to adequately grasp market and competitive trajectories.
- Lack of adequate investment in training and development for skills upgrading.
- Perceived high cost of training, without clear cognizance of the range of benefits that can be derived from a highly skilled and competent workforce.
- Poor understanding of future skills needs and development. Insufficient market, technological and competitive intelligence.
- Shortage of local trainers with the necessary expertise and experience to conduct training that is effective in developing the required skills and competencies.

Impact/Consequences

- Lack of relevant local training courses leads to high costs in human development. Creates high dependency on foreign trainers who are not only expensive but also transitory: they conduct one-off trainings and are often unable to provide or cater to continuous organizational training and development needs or comprehend fully the local context of operations.

- Weakness in skills and competencies (e.g. lack of operational and technological understanding, weaknesses in soft skills (language, service orientation, etc.)) lead firms to either out-source or set up operations in neighbouring countries.

Challenge 4: Attracting and retaining creative talent is a major challenge for firms

Inability to attract and retain highly skilled expertise and creative talent hampers the ability of firms to engage effectively in the process of innovation so as to yield strong product and process innovation outcomes.

Cause Factors/ Reasons for Issue

- Highly bureaucratic and hierarchical firm structures and processes do not provide environments conducive to innovative behaviour.

- Low levels of investment in R&D coupled with lack of supportive environment to attract and develop talent for innovation.

- Short term focus at the expense of long term innovation allows little scope for highly talented individuals to develop, refine and extend their skills.

Impact/Consequences

- Best local talent leaves for employment with MNCs or abroad, where they are not only remunerated but are provided organizational environments, support and leadership that facilitate innovative endeavours.

- Insufficiency in both the quantum and quality of advanced skills means firms have little scope to create novel break-through innovations. Without sufficient local product, market and process innovation, firms become reliant on the advances of others to compete in the market place. This results in imitative or follower products providing a low basis to build high value added offerings and differentiated positions.

Challenge 5: Shortage of talent with advanced skills and specialist Expertise

There is a shortage of advanced skills and specialist expertise required for break-through advances and innovation. This severely constrains the ability and possibility for innovation to take place. Often it creates a serious hollowing out of critical sections of the organizational strata.

Cause Factors/Reasons for Issue

- Lack of integrated high skills training and development.

- Lack of investment by firms in developing specialists' skills, for fear that people may leave and join competitor firms.

- HEIs are failing to develop specialist skills that are on the edge of research frontiers. The focus of HEIs is on creating average graduate attributes in large number rather than research excellence and high end knowledge skills and competencies.

- Lack of HEI who possess frontier research capabilities to drive the development of creative and innovative problem solving individuals.

- Weak interaction and collaboration between industry and educational institutes creates mismatch in the high-end skills needed by industry and those developed by HEIs.

- Weak triple-helix.

- Unwillingness of firms to pay and retain high skills individuals who can command good salaries or are able move elsewhere should they find organizational environments to be unsatisfactory for their needs.

Impact/Consequences

- Failure to map out future advanced skill needs due to inadequate fore-sighting of industry development and technology trajectories. This leads to the creation of an abundance of average or even specialist skills that are not required by industry, and a severe shortage of the range of advanced skills required by industry.

- Without adequate advanced skills coupled with firm environments that do not sufficiently upgrade and develop skills of individuals once they join the industry creates real possibility of a hollowing out at the middle and top level of advanced skills. This has serious repercussions on a firm's ability to innovate.

Challenge 6: Lack of fore-sighting and visioning

Poor understanding of frontier edge developments in technology, science and markets leads to a focus on development of outdated skills and "Me-too" products of yesteryear.

Cause Factors/Reasons for Issue

- Lack of strategic visioning and industry fore-sighting.

- Weak triple-helix (university, government and industry cooperation and collaboration).

- Inability of triple-helix agencies to keep pace with leading developments due to weak and un-coordinated interactions.

- Lack of HEIs who possess frontier research capabilities to drive the development of creative and innovative problem solving individuals.

- Little fundamental research taking place, coupled with a lack of awareness by the industry as to where it is taking place and how to access it.

Impact/Consequences

- Lack of long term coordinated investment in specific type of high skill sets (e.g Data Analytics, FinTech, Industry4.0, IoT) and deep understanding of where markets are heading leads to the failure of investments to make an impact due to the resources being spread too thinly, directed to the wrong areas and places or lack of focus and patchiness in its co-ordination.

- Emergent advanced skill needs mismatch. Failure to build higher order dynamic capabilities (Adaptive and Innovative).

- Lack of fore-sight, planning and coordinated implementation leads to significant waste of resources, resulting in significant opportunity cost.

Challenge 7: Quick to market without developing the foundational and driver conditions of the ecosystem – high failure rates and poor reputational problem

Leap-frog attempts through the non-sequential use of skills and knowledge to drive innovation often result in failure.

Cause Factors/Reasons

- Insufficiency of higher level skills leads to deployment of lower skills in higher order activities.

- Failure is consequent of weak assimilation and internalization of knowledge.

Impact/Consequences

- Lack of adequate skills at higher levels (mid-level technical or advanced skills) creates a vacuum into which lower skills are pulled as a compensatory mechanism. However, the hollowed out mid-level is not readily compensated by lower skills, and use of basic skills to develop higher order DCs results in failure.

- Without analytic understanding of the deep-rooted cause of failure, the cost of failure breeds a cycle of risk averseness.

- Firms start to avoid investing in R&D led innovation. This creates a mind-set that innovation based entrepreneurial activity is not for them. Ultimately, it closes out the propensity to innovate.

- High failure rates lead to a reputational problem hence resulting in difficulty in branding and positioning the products and services in high value-added markets.

Challenge 8: Poor Market Intelligence

Weak understanding of mega-trends and innovation and technological trajectory leads to poor responsiveness to market and technological needs for innovation. It also serves to create a high level of dependency on others, in terms of market followership and technology dependence.

Cause Factors/ Reasons for Issue

- Inadequate approach to market understanding.

- Superficial approach to market intelligence, though naïve ad-hoc internet search for market insights and knowledge. Low level of systematic and planned research to develop market strategies.

- Increasingly volatile market conditions. Potential for "system shocks" is becoming more frequent as technology cycles compress and social and market dynamics alter at a faster pace. Likelihood of competitive failure is increased.

- Weak awareness and responsiveness to market allows foreign MNCs to dictate trajectories of local development that are weighed in their favour. Creates high dependency on foreign entities.

- High level of dependence on government agencies and intermediaries for market intelligence.

- Short-term competitive outlook without long-term collective vision.

- Lack of network based sharing due to low level of trust that prevail within industry associations and between industry and government agencies and institutions.

- Search for "off-the-shelf" solution rather than conduct research to develop specific and novel innovative solutions.

- Reliance on others (e.g. expensive consultants) to provide answers to basic problems of industry development

Impact/Consequences

- Lack of sharing of information to create collective understanding of long term trajectories, and develop win-win strategies for the ecosystem.

- Even when there is understanding or leadership position in specific areas, the industry fails to create integrated flows to fully capitalize on opportunities. (Lack of integrated k-flow).

- Lack of Future Preparedness due to low future orientation.

- Industry Ecosystem is fragmented in its approach to future challenges.

Challenge 9: Firms take a short-term outlook

Firms are absorbed in their pursuit of short-term profits and fail to invest in R&D and long-term firm structural adjustment. This approach focuses emphasis on market instrumentalism as the primary modus operandi of success.

Cause Factors/ Reasons for Issue

- Focus on low-level upgrades.

- Incremental improvements to products or process through imitative process.

- Unable to create ambidextrous balance (short-term versus long-term; explore versus exploit).

- Passively follow superficial trends rather than actively create trends.

- Domestic consumers not sophisticated or demanding enough to drive innovative behaviour in firms.

- Domestic market is small and constituted by passive consumers, not trend leaders.

Impact/Consequences

- Firms become complacent in the process of fulfilling domestic consumer needs and fail to see the logic of taking innovation risks.

- Long-term innovativeness is compromised.

- Contributes to dependency on others knowledge, technology and innovation.

- Once organizational innovativeness is compromised or lost it is difficult to regain the acumen to accept uncertainty and risk that comes with innovation. The re-building process for innovation is difficult and protracted.

- Firm product/service portfolio becomes heavily deterministic and short-term focused, creating a situation of long-term unbalance.

Challenge 10: Weak Institutional Framework

The lack of a collective view of industry and poor strategic coordination amplified by poor infrastructure and processes for effective implementation lead to system based failures. The ecosystem fails to function optimally. Different parts of the system work against each other, rather than mutually reinforce multiple knowledge flow outcomes.

Cause Factors/ Reasons for Issue

- Agencies work in isolation.

- Institutions do not possess the capability or knowledge culture to be able to drive industry system and network to end goal vision.

- Lack of capable people with depth of knowledge and expertise to guide and direct and provide governance oversight.

- Weak communication between triple helix parties leads to misunderstanding and mistrust.

- Lack of singular oversight body to drive strategy formulation, implementation with attached KPIs and responsibility creates ambiguities and avenues to circumvent plan realization.

Impact/Consequences

- Gap between policy and implementation. Many policies are sound on paper but lack sufficient investment and effort to ensure implementation process is sound and frictionless. Severe problems and contradictions arise as a consequence of poorly planned implementation or poor adherence to implementation processes.

- Many policies and programs are initiated but aspired outcomes are rarely achieved due to numerous anticipated and non-anticipated roadblocks within the system.

Challenge 11: High level of bureaucracy and lack of a business-friendly environment

Too many changes in regulations, initiatives and programmes create confusion, fatigue and disinterest within stakeholders and industry firms.

Cause Factors/ Reasons for Issue

- Short-term outlook of players in the industry.

- All parties create self-serving programs, initiatives and regulations without broader concern of the system as a whole.

- Failure to reconcile differing priorities across stakeholders because of KPI misalignment.

- Lack of trust between parties as a consequence poor understanding of each other's needs.

Impact/Consequences

- Failure to understand and appreciate the industry ecosystem. All parties engage in self-focused behaviours based on narrow component KPI rather than broader collective KPI of the industry and ecosystem optimization.

- Stagnation of initiatives with little progress to realize the vision of knowledge economy.

Challenge 12: Weak R&D ecosystem – lack strategic focus in key frontier technologies

Dormant R&D system because of insufficient investment in research and development activities, poorly defined and targeted R&D focus areas and weaknesses in skilled workforce to capitalize on the investment(s).

Cause Factors/ Reasons for Issue

- Infancy of STEM R&D in key sectors of the economy.
- Lack of expertise to access and unlock S&T for optimal innovation outcomes.
- S&T taking place locally is not relevant to industry needs.
- Reliance on foreign technology and know-how creates long-term "lock-in" into particular technology trajectory or systems. Dependency creates a vicious cycle that dampens initiatives to create local innovations.
- Lack of knowledge transfer clauses in contract with foreign firms. Foreign firms continue to negotiate contracts in which little knowledge transfer is required, in contrast to countries like China, Singapore, Taiwan where strong and clear stipulations are made and followed up to ensure knowledge transfers have taken place.
- Weak regulatory enforcement of IP infringements creates disincentive to be involved in R&D efforts.
- Lack of focused R&D. R&D efforts are diffused and not carefully directed to specific areas where it is possible to build both mass and momentum.

Impact/Consequences

- Experiences of IP or NDA infringement are commonplace and serve to create low-trust mind-setd and behaviours. Such experiences lead innovators to ask "what is the point of innovation if value creation cannot be protected".
- Poor understanding of domestic industry strengths and market and technology dynamics results in inability to correctly select focus on key niche areas that will be critical for competitive success.
- Diffusion of S&T is slow, making it difficult to realize spill-over benefits.
- Heavy technology and knowledge dependency on others.

Challenge 13: Lack of a knowledge sharing culture

The knowledge sharing culture in the subsectors is not as pervasive as compared to more developed countries and this is attributed to a number of reasons mentioned below.

Cause Factors/Reasons

- Firms have historically been successful without needing to innovate by serving in low-end markets. The prevailing belief is that the status quo will continue into the future.
- Culture of dependency out of an over reliance on others (government, foreign MNCs, etc.).
- Strong hierarchical structure and cultural predisposition to not to question status quo creates low innovation reflexes, especially when rewards are directed to unquestioning of authority and conventional ways of doing things and thinking.
- Narrow and competitive zero-sum perspective of the market place fosters a highly secretive, non-sharing culture.

Impact/Consequences

- Firms will continue with current structures and systems for short-run profits, until it is too late. Once industry shocks or disruptions take place firms will be ill prepared and lack time to adequately respond.
- Failure to build knowledge culture weakens the drive for innovation and move to high value add parts of the spectrum.
- In the long run survival will be questioned by disruptive innovators.
- The industry shake-out will test the survival ability to the limits, with many having to exit.

20.2 The Way Forward

Comparative analysis of the knowledge ecosystem of the Malaysian sub industries suggests it to be weaker than the ecosystem in more developed countries. These weaknesses hinder movement to a higher level of dynamic capabilities, process improvement and product market development; hence, their global competitiveness. To ensure the selected industries are able to become more knowledge intensive and enable a high-income economy, seven major strategic thrusts are proposed. They are outlined below.

Strategic Thrust 1: Knowledge Environment - alignment of policies and strategies to global industry trends, standards and best practices

The industries and global economic landscape are continuously being transformed by forces of globalization, liberalization, regionalization and digitization of the global economy. The transformation to the global economy is also being shaped by demographic shifts, environmental consideration and adherence to global best practices and standards. To be part of the new world economic order, countries such as Malaysia should align policies and strategies pertaining to talent, infrastructure, technology, institutional reforms, governance systems, monitoring, surveillance, S&T plans and programs, R&D incentives and other support systems to meet these global best practices and standards.

Strategic Thrust 2: Knowledge Institutional Systems - develop and optimize the industry ecosystem rather than focus on developing component parts of the ecosystem network in isolation.

Innovation in the industry ecosystem is strongly influenced by the existence or absence of facilitative conditions. Innovation is the consequence of a range of activities by different actors (Universities, Government agencies, firms in the industry). Innovation can be enhanced or halted through such things as regulations, policies, programs, existence of top class research universities, etc. All of these network agents engage in actions that have effect in determining how innovation is conducted, to what level, etc. The ecosystems perspective also is about co-ordination, planning and implementation. The goal in the ecosystem should be to create "Frictionless Optimization of the Ecosystem". In other words, the systems should remove hindrances and barriers to knowledge flow and use, whilst putting in place mechanisms to enhance and amplify the effects of knowledge in terms of innovation outcomes. Numerous forms of actions can be taken at the ecosystem level such as:

- Greater co-ordination and integration of Master plans with clear focus on areas of development that are strategic to local industry, clear implementation plans and milestone KPIs, and allocation of roles and responsibilities of each in contributing to the common end-goal.
- Formation of an oversight champion to address the needs of collective development of stakeholders, including that of other complementing industries.
- Increase coordination and collaboration between trade associations, government agencies, and universities to drive change in the industry.

Strategic Thrust 3: Knowledge Approach - adopt a knowledge approach (strategic outlook) that stresses innovation as a fundamental part of organization's strategy.

Knowledge approach is determined by the types of decisions leadership make with regard to innovation, these include:

- Substantial investment in R&D for innovation. Investment in R&D is structured based on the size and needs of the firm. Small firms can access R&D through partnerships or linkages with research institutes, such as the Fraunhofer Institute and the Steinbeis approach.

- Innovation requires firms to be ambidextrous. Oftentimes, innovation creates pressures within the firm that are contradictory or in opposition to each other. The major challenge is how well the firm balances "explore versus exploit". Many firms in Malaysia focus almost exclusively on a narrow version of exploit (license technology and manufacture at lowest cost). In such approaches, very little innovation (product or process) takes place.

- Knowledge approach also captures time orientation (short run profit versus long term bets on innovation).

- Innovation requires developing a risk portfolio that contains both uncertain bets (innovation experiments, such as fundamental frontier research based developments with high pay-offs), middling bets (incremental innovations) and safe bets (exploiting existing markets through minor cosmetic adjustment to meet customer needs). A balanced portfolio creates a balance in the mix between exploitation and exploration activity such that it allows long term competitive advantage and competitiveness.

- Ambidexterity creates new competencies whether gradually milking and weaning away from older competencies.

- Adopt organizational perspective that is fresh and open to new ideas, stretches organizational competencies and cannibalizes competencies that are outdated for emerging marketplace.

Strategic Thrust 4: Knowledge Capital - sustainable and holistic skills and talent strategy to help drive innovation strategies

To ensure that firms are able to transition to higher value add activities and sustainably innovate requires a holistic approach to skills and talent. This includes basic skills and advanced skills. Without the requisite quantum and quality of talent any effort to move up the higher value-add spectrum is handicapped towards failure. Holistic approach to talent for the needs of industry requires building a complex mosaic with many components, which are discussed below.

Appreciation of Role:

- Build an understanding and appreciation that human talent is a key feature of national competitiveness and the nation's knowledge economy aspiration.

Future Skills Needs Mapping:

- Clear mapping of the diverse range of talent and skills needs for the industry at the current moment and into the future.

- Identify specialist skills and areas that need to be developed in order for competitive success into the future.

- Map of different skills levels (basic to advanced) and the development trajectories that they need to take to create a robust innovation driven industry.

Curriculum Design:

- Curriculum to be designed with the involvement of key industry players, trade associations and universities, and aligned to national strategic priorities.

- Curriculum provides a clear career pathway. It should articulate how development can take place from certificate to graduate to doctoral and post-doctoral.

- Higher focus on interdisciplinary and multidisciplinary skills and knowledge.

- Utilize internships, job placements and training as mechanisms to ensure that graduates are "ready for industry".

Training and Development:

- Ensure that competencies and skills of individuals are upgraded and evolve over time in line with needs of industry through continuous investment in training and development.

- Use job training, apprenticeship, mentored learning as on-going part of life-long learning.

- Train the Trainer Program: Develop capability and expertise of local trainers, to enable cost effective delivery of training and development programs geared to specific needs of industry.

- Create training programs that are accessible and flexible to the needs of industry.

Promotion and Remuneration:

- Careers in the industry need to be promoted through various media, digital platforms and meetings to showcase the opportunities and career paths that can be followed. Exemplar models of success and achievements of people in the industry.

- Build an appreciation of the role of the industry as important contributor to national economy.

- Remove any existing negative industry stereotypes.

- Ensure that remuneration packages are competitive, and promotion pathways exists to the very top of the ladder for those with passion and dedication.

Strategic Thrust 5: Knowledge Competencies - develop deep understanding of the strategic evolution of the industry and its associated technological, market and competitive dynamics.

Understanding the Strategic Evolution of Industry:

- Fore-sighting and signposting of the future development of industry is critical for the correct nurturance of competencies.

- Identify emerging megatrends (socio-economic, market, technological) to evaluate likely shaping impacts on industry, and assess their implications.

- Select strategic pathway(s) for the development of industry from its current day position to future position.

Stretch Existing and Develop New Competencies:

- Map current competencies and how they need to be stretched or developed anew for future industry scenarios.

- Undertake applied research that is relevant to future development of the industry.

- Based on chosen strategic pathway, build or strengthen centres of excellence through high-end research and close links with industry.

- Incentivise universities and research institutes to develop specific areas of expertise relevant to current and future needs of industry.

- Create U-G-I internships and job rotations to develop capability and awareness of individuals in emerging areas so that they are well prepared for the likely direction of the industry.

Exploit Existing Competencies:

- Deep market understanding through systematic digestion of market intelligence will allow more refined enhancements of existing product service offerings.

- Combine traditional information with new advanced analytic modes to better understand consumer behaviour and market evolution. Combine anthropological observation, surveys with data analytics and neuro-business for enhanced consumer understanding.

Strategic Thrust 6: Knowledge Learning and Transfer - knowledge transfers must be managed and not left to chance processes.

Significant effort is made to attract MNCs and foreign firms into Malaysia through a variety of partnership agreements and joint ventures. However, the level of knowledge transfers that takes place is not comparable to the expectation based on the number of JVs and level of FDIs. Knowledge transfer needs to be explicitly managed rather than left to chance. The process can be divided into two key parts that need attention and management: an external part and internal part.

External K-transfer Component:

- Scan the environment and enter a JV or collaborative partnership with companies with the requisite skills and competencies. Normally K-transfer is most successful within long term partnerships in which strong levels of trust and cooperation are engendered.

- Explicitly include in the agreement a clause that focuses upon knowledge transfer, its nature, boundary and span. Explicitly stipulate specific K-transfer metrics for measurement and tracking purpose.

- Create win-win partnerships between firms, research institutes, universities, MNCs.

- Utilize schemes such as Global Incentives for Trading (GIFT) to promote Malaysia as a regional hub for R&D in key identified areas to attract leading anchor firms and joint venture partners.

Internal K-transfer Component:

- Common failing of K-transfer is the assumption that partnerships will automatically create an inward K-flow. A partnership and even an explicit clause just set up the platform for k-transfer to take place. However, specific mechanisms must be built-in to ensure it does.

- One successful mechanism is use of a Teaching Company Associate (TCA), in which a well-qualified staff and/or doctoral student is made responsible for k-transfer. Sponsored programs, such as the MyBrain initiative are highly suitable for this purpose.

- Tracking of k-transfer should be instituted within the process, through carefully thought through metrics.

Strategic Thrust 7: Knowledge Leverage - knowledge needs to be shared and used to create effect, not just collected and stored.

Knowledge can create multiplier effects through two primary pathways and they are outlined below.

Knowledge and Resource Sharing:

- Sharing of knowledge within the industry ecosystem creates flow that amplifies outcomes. Shared knowledge once it is assimilated for the specific context of the firms in a network has potential to be transformed into innovation outcomes. If the firms in the network (or ecosystem) possess the necessary DCs they are able to put to use shared knowledge very effectively to create innovation.

- Create an industry association or federation that has extensive network of industry members and includes in its membership research institutions, universities that are conducting leading edge research in specified fields, as well training and development and marketing support services. Pool the association's resources to create a repository of knowledge (market, technical, frontier research) and support dissemination of knowledge to members.

Such industry associations can be the backbone of industry, chartings its development to highly innovative sector through 1-stop supply of range of knowledge, advice and support service.

Knowledge and Resource Use:

- Knowledge use in innovative activities is often constrained by prohibitive costs of technology and machinery. If we are able to use resources effectively, we can benefit from economies of scale.

- For example, research institutes and universities often possess specialist labs and equipment as well as staff with the capability to run them. Often times these very expensive assets can lie idle. By allowing open access, SMEs can do R&D which otherwise would be exorbitantly costly and beyond their means.

- Create translational R&D infrastructure, such as Fraunhofer-GesellSchaft, which provides access to new and innovative technology for companies that otherwise would be unable to afford it. It has 67 research institutes spread across Germany that are focused on different fields of science and technologies according to the needs of German industry

20.3 Concluding Remarks

The MYKE III (Phase 2) provided valuable insights on the key knowledge enablers that contribute to the development of the dynamic capabilities, process improvement and product market development in 8 key industries. The study also identified key strengths and weaknesses in knowledge ecosystems of each of the industries. These findings provide directions to refine existing policies and strategies and institutional set-up to strengthen the knowledge ecosystems of each of these industries so as to ensure that they are able to move up the knowledge and innovation value chain.

Increasing knowledge intensity and enhancing the innovative capacity of Malaysian industries will be critical for transforming Malaysia into a globally competitive and high income economy. The global economy is undergoing unprecedented change powered by the four global forces mentioned above. Countries that are able to quickly transform their industrial ecosystems to be knowledge-driven will not only be able to adjust to the forces that are shaping the global economy; but, be at the forefront of leading the transformation of the global economic landscape and contribute to the sustainable development of the global community.

End of Final Report – Phase 2

Acknowledgement

Compiled and contributed by:

Prof Mahendhiran S. Nair, *Vice President (Research & Development), MONASH University Malaysia, CEO of Monash Malaysia Research & Development (MMR&D)*

Prof Pervaiz K Ahmed, *Director of Global Asia in 21 Century (GA21), Deputy Head of School (Research), MONASH University Malaysia*

Assoc Prof Santha Vaithilingam, *Cluster Leader of GA21, Head of Econometrics Department & Business Statistics, MONASH University Malaysia*

Dr Au Wee Chan, *Lecturer, School of Business, MONASH University Malaysia*

Daniel Lee Lih Wei, *Senior Manager of MMR&D, Project Manager of GA21, MONASH University Malaysia*

Ritchie Lim Tzen Wing, *Admin Executive of GA21, MONASH University Malaysia*

Eng Yeung Jiah, *Graduate Research Assistant of GA21, MONASH University Malaysia*

Nazirul Hazim A Khalim, *Research Assistant of GA21, Monash University Malaysia*

Yeng Hong Qing, *Research Assistant of GA21, MONASH University Malaysia*

Khairunnisa Hamdan, *Research Assistant of GA21, MONASH University Malaysia*

Mazzatul Raudah, *Research Assistant of GA21, MONASH University Malaysia*