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Reading between the stripes. . .

Understanding the industrial success of Singapore and Malaysia

Report of the MET Overseas Research Project 2010

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Understanding the industrial success of Singapore and Malaysia

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Industrial foreword

Any company looking for leading countries in which to locate high-end manufacturing or R&D, as opposed to high labour content low cost manufacturing, would do well to consider Singapore and Malaysia. This report by a group of recent Cambridge engineering graduates provides a very good "zero-based" analysis and comparison of the merits of the two countries. The authors start from afresh and base their views on a two-week intensive tour, visiting some thirty companies and government agencies to build their picture in a structured way. This makes the report useful to any company considering such a move and makes interesting reading for those already present in either country.

The report reviews existing company investments in sophisticated manufacturing and R&D and charts the trends of the last twenty years. Both countries have made great efforts to move their economies up the value and knowledge chain and both make very attractive offers to investors in the form of business parks and serviced facilities as well as competitive tax structures. But there are important differences in the availability of land and resources, in fiscal regimes and in the approach to the protection of national industries. The report analyses these differences in a way that would be helpful to a company seeking to make a choice based on its own priorities and needs. The report also looks at the growth of indigenous companies in the high-value manufacturing and research area as well as at the approach to the challenges of sustainability in each country.

The availability and development of sufficiently skilled scientists and engineers is a challenge in almost all countries. It is encouraging that Cambridge is making sure that some of its best engineering graduates have a clear idea of the opportunities and challenges in other countries as they start their own careers.

Sir Mark Moody-Stuart
Former Chairman of Royal Dutch Shell
Co-Chairman of Singapore British Business Council
President of the British Malaysian Society

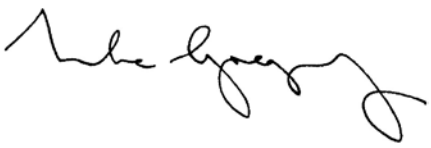
Academic foreword

Manufacturing involves the translation of ideas and opportunities into products and services. It creates social as well as economic value. Many argue that it is one of the few ways in which real and enduring value can be created. The UK has been through a period when manufacturing was seen as less important than services but most people now agree that we need both. Indeed the distinctions between manufacturing and services are increasingly unhelpful as manufacturers adopt service-oriented business models to capture the maximum value from their skills. The renewed interest in manufacturing raises many questions about the rapidly changing global industrial landscape. Who are today's manufacturing leaders? Where are the opportunities for partnership and growth? What is the competitive landscape? These are some of the questions that this year's team of MET graduates have sought to address, choosing Singapore and Malaysia as the focus of their enquiry.

Singapore and Malaysia lie at the heart of the global industrial landscape but are sometimes overlooked in favour of their larger neighbours. But as the team points out in their report these two countries have been leaders in developing vibrant industrially-oriented economies and dramatically raising the living standards of their people. They provide in many ways a 'bridge' between east and west enjoying close cultural and economic links with both and a 'hub' where both worlds can meet. And they do this while retaining their distinctive cultures and commanding wide respect for their economic and social achievements.

This year the MET team has done an excellent job in bringing to our attention the strength and dynamism of the two countries and highlighting their distinctive industrial practices and policies. In their different ways the two countries are sophisticated global players with clear insights and access into the emerging giants of the region while remaining well connected to the older industrial economies. Global companies increasingly recognise the importance of 'plugging in' to the heady growth of the East; Singapore and Malaysia provide an ideal jumping off point for such engagement.

I am confident that industrialists and policymakers will find much of value in this report and I congratulate the team on a complex job very well done. I would particularly wish to thank the many generous sponsors and hosts who made the project possible.



Professor Mike Gregory
Head of the Institute for Manufacturing
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1 Executive summary

This report presents the conclusions of a two-week study tour of Singapore and Malaysia and almost 12 months of preparatory research by Manufacturing Engineering Tripos (MET) graduates at the University of Cambridge.

The annual MET Overseas Research Project studies countries of importance in international manufacturing. The project has three main aims: to provide a global perspective on manufacturing operations; to strengthen links between UK industry, the Institute for Manufacturing and the countries concerned; and to deliver high quality research on the region.

Projects in recent years have focused on China, India, and Brazil. This year, the team chose from a shortlist of regions including Mexico, South Africa, South Korea and South East Asia – all of which have received less attention than the BRICs. Of these, Singapore and Malaysia were selected for their economic success, close proximity and shared history; they sit in a unique geographical position, forming a bridge between East and West.

Key findings

- Both countries wish to reach and maintain high positions in the industrial value chain. Malaysia is hoping to reach 'Developed Country' status by 2020; the aim is that knowledge will replace low-cost labour as the country's competitive advantage. Educational challenges, however, remain in some industries.
- Both countries have developed industrial parks to encourage investment and to offer the benefits created by clustering companies together. Strong incentives (usually relating to tax) are also used to attract foreign direct investment.
- Sustainability concerns were often lower than the USA or Europe and companies' environmental practices were usually driven by global corporate policy.
- Both countries seek investment in technologies based on existing capabilities or those considered of strategic importance (e.g. Singapore's limited resources, especially water). Varying degrees of governmental intervention exist.
- Singapore is competing on an international level as a centre for high-value manufacturing and R&D. Malaysia currently competes on a regional basis as a manufacturing location.

2 Introduction

2.1 Project objectives

Singapore and Malaysia are often overlooked when considering worldwide economic trends, yet they play an important role for manufacturing in South East Asia and internationally. Their success has been driven by several factors including increased foreign direct investment (FDI), alongside governmental efforts to move up the value chain through high-value manufacturing and R&D, particularly in sustainable technologies. This year's MET Overseas Research Project divided its study of the region into three main research areas:

- *The manufacturing and R&D capabilities that exist in both countries*
- *The development of FDI and local industry, including the influence of the region's policy and culture*
- *The effect on the region of the global focus on sustainability*

These topics provide a framework for identifying and assessing the countries' industrial success. They also align with the areas of interest of the project's primary stakeholders: the Institute for Manufacturing (IfM) and industrial sponsors.

2.2 Historical and regional context

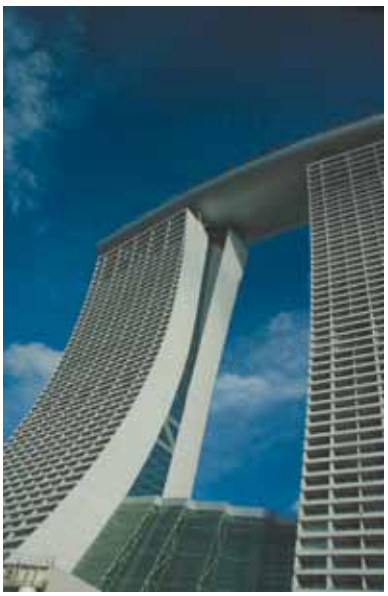
Situated in South East Asia, Singapore and Malaysia have a shared history of trade as far back as the 1500s. In the early period of development, Melaka in Malaysia developed as a stopping point between East and West under Portuguese, Dutch and British rule. It wasn't until the 19th Century that Singapore began to overtake Melaka as the main trading port on the East-West route whilst the discovery of tin, rubber and palm oil sustained trade in the Malaysian states.

A milestone for Singapore came with its independence from Malaysia in 1965 (by then a group of federated states) following a short period of unity after independence from Britain. Under the stewardship of Lee Kuan Yew it developed rapidly, with a focus on attracting foreign investment for manufacturing and refining of imported goods. This was achieved through strict governmental control and targeted development of industries and infrastructure, a situation that remains largely unchanged today. Throughout this time, Malaysia benefitted from its natural resources; in particular, crude and palm oil revenue helped fuel rapid economic growth during the 1960s, followed by a growth in manufacturing from the 1970s as the country mimicked the Asian Tigers by focusing on attracting FDI.

Today, the political systems of both countries sit in contrast. Singapore retains tight control over the state through the dominance of a single political party and remains a country that operates in many ways like a company. Nearby, Malaysia retains an array of political parties that reflect its cultural diversity, functioning under a federal system of states.

The shared history and close economic ties of the countries provide a context for this project and help to explain why the two 'cousins' have been chosen as the subject of a joint investigation for each of the three research topics.

2.3 Research topics



Topic 1: R&D and manufacturing capabilities
There is a common perception that foreign investment in the region is simply driven by the area's lower labour costs compared to Western economies. In fact, government policies have focussed on moving the countries up the value chain in order to develop higher-value manufacturing and R&D. This applies in a range of areas that complement existing industries, as well as supporting new ones. The approach has attracted a number of foreign investors looking to benefit from expertise in particular processes or technologies.

These manufacturing and R&D capabilities are an important consideration for both foreign and local companies and they help us to understand the future direction of the region. This topic therefore considers what these capabilities are, along with examples of where companies have utilised them successfully.

Topic 2: Foreign direct investment and local industry
There are numerous recent examples of companies from Europe and the US moving to the region, yet this has happened alongside the emergence of successful native companies. Singapore, in particular, has successfully built its economy by attracting foreign investment and human capital over the last 40 years. By comparison, with the exception of specific high profile MNCs, Malaysia has been a more recent entrant into the international economy, but now plays host to several high-profile emerging industrial sectors.

It would also be easy to assume the countries have only achieved success through these foreign multinationals. They are not without their own international success stories, however, for example the Malaysian conglomerate YTL, and Singapore's SembCorp Marine Ltd.

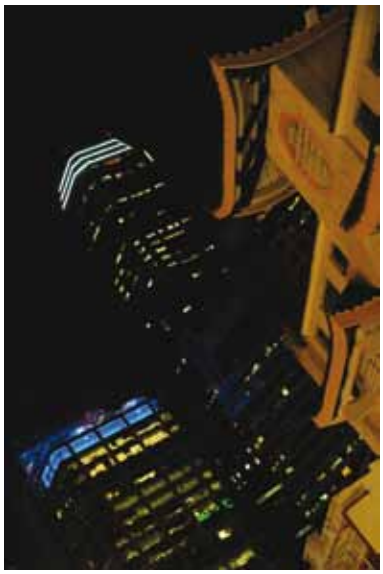
This topic therefore investigates foreign and local contributors to the economy and covers the following: the strategies that national and regional government have used to attract investment; how the countries have supported their local industries; and what social and cultural traits have influenced this development.

Topic 3: Sustainability

There is an increasing global focus on sustainability, both within companies and at a governmental level. This impacts manufacturing firms and will require changes in business operations from supply chain to product design. Whilst the situation for companies in the US and Europe is becoming clearer, the implications for SE Asia are not well documented in either the current academic or business literature.

This topic therefore aims to identify the drivers for change in relation to sustainability; whether through governmental efforts or external factors. Technologies in this space are also presenting opportunities for manufacturers worldwide and some of these are contributing to the region's growth. These have both been investigated, alongside how sustainability features in government policy.

2.4 Research methodology



The intention of this project is to provide a broad overview of the manufacturing activities and success of the two countries (based on the three key research topics from a manufacturing firm's perspective). The two countries were selected based on initial investigations which highlighted their importance to global manufacturing.

The research started by conducting a review of the existing literature to provide the foundations of the research and interview questions. Visits and semi-structured interviews were then carried out with 30 leading manufacturing firms and institutions (in Singapore, Johor, Penang, and Kuala Lumpur) during a 2-week visit to the region in July 2010. As far as possible, interviews were conducted with senior members of staff who possessed a comprehensive overview of both local and global operations of each company. Visits have provided potential future case studies along with evidence supporting or challenging existing understanding of the region. The companies visited were selected by the team, based on the following criteria:

- Their potential contribution to each of the three research areas
- Their leadership in the business environment both at a national and international level
- Their development or use of novel technologies or business processes
- Their interest to the project's stakeholders.

2.5 Report structure

The report is divided into four further sections. The next three sections cover each of the research topics using the methodology described above, whilst the final section contains the overall conclusions of the project.

Case studies are provided in boxes alongside the text throughout the report, based on the companies and organisations visited as part of the Study Tour. Additional supporting examples, derived from literature research, are included in the text itself.

3 The relative manufacturing and R&D capabilities in both countries

3.1 Introduction

The understanding of the capabilities[i] available to firms in any given industry is of increasing importance in the context of increasing global outsourcing and off-shoring. This section will explore the manufacturing and R&D capabilities of both countries, investigating key sectors in each country and the advantages of locating in the region. This section will be of benefit to both UK and international firms who may wish to locate in the region.

Manufacturing is of economic importance to both Singapore and Malaysia, providing valuable jobs and resulting in overseas investment. In certain sectors (especially electronics) the two countries are world-leading, having attracted a number of large international companies to establish both manufacturing and research centres.

The countries also face contrasting challenges. Whilst Malaysia has a significant amount of natural resources, Singapore has comparatively little. Consequently, Singapore is highly reliant on imported resources; e.g. water, electricity supplies, and imported materials. Human resources have hence become a key asset of the country, although advanced infrastructure and technologies are also considered to play an important role in attracting overseas investments. Malaysia is somewhat different. Historically a low-cost manufacturing region, it has recently aimed to move up the value chain to higher-value manufacturing by placing less importance on its raw materials and processing industry.

Case Study: Yamazaki Mazak

Yamazaki Mazak Singapore is Japanese owned and forms part of one of the world's leading manufacturers of precision CNC machine tools. Mazak has invested heavily in high-value, high-tech CIM equipment, (incentivised by the Singaporean government) and upgraded the plant to a CyberFactory in 2005.

Mazak Singapore produced 6000 machines in 2009 that were distributed across the globe; their largest markets are SE Asia, Europe, Japan, and USA. Managers cited strategic geographical location, good infrastructure, and the educated workforce as key reasons for their locating in Singapore.

3.2 What manufacturing is in the region?

3.2.1 Manufacturing in Singapore

Since gaining independence from the UK, Singapore has positioned itself as a global manufacturing hub. Government measures to develop selected sectors means that manufacturing currently contributes approximately 20% of the country's GDP[1]. Key capabilities (including an advanced logistics network, strategic global location and availability of educated labour) have enabled Singapore to become a leading global manufacturer in the electronics, chemicals, precision engineering and biomedical sectors. With increased labour costs and competition from other Asian countries, it continues to focus on new, emerging industries in high-value manufacturing.

With a small domestic market, manufacturing primarily targets products for export. Combined with the lack of natural resources, the country's focus is therefore on facilitating complex logistical networks with advanced infrastructure to allow quick transit of goods. Singapore is located on the Strait of Malacca, one of the busiest shipping lanes in the world[2]. This benefits many industries and Singapore's electronics companies exploit this international logistic network, which is heavily integrated with other South East Asian countries.

Unlike many other Asian countries, Singapore is constrained by limited availability of land, although it is seeking to compensate for this through an active program of land reclamation. The government is thus

[i] Whilst there are different definitions for the term "capabilities" in an industrial context, in this report the term refers to the availability of key resources (machine or human), infrastructure, supporting ecosystem etc.

particularly active in generating prosperous conditions specifically for those manufacturing sectors deemed crucial to Singapore's future. The JTC Corporation is a government-backed organisation responsible for providing manufacturers with either industrial land to establish factories, or ready-built factories to immediately begin manufacturing[3]. Such initiatives have resulted in dedicated industrial parks, each concentrating on specific industries. For example, Tuas Biomedical Park was established to encourage biomedical manufacturing[4] and Jurong Island primarily focuses on the chemical sector[5]. Such clustering allows close links between neighbouring facilities on Jurong Island, with finished chemicals from one factory being fed directly into connected facilities.

Due to a high dependence on the export market, manufacturing output in Singapore is directly impacted by fluctuations in world demand. Manufacturing declined in both 2008 (4.1%) and 2009 (4.2%)[6] as a result of the global recession, with demand from the United States, Europe and Malaysia falling sharply[7]. As of June 2010, manufacturing exports were showing signs of strong recovery; this growth is projected to be led by emerging economies[8].

3.2.2 Manufacturing in Malaysia

Unlike Singapore, Malaysia's natural resources have provided it with a platform from which the country has built successful agriculture and primary processing industries. Key sectors include rubber, palm oil, timber and textiles. In recent years, Malaysia's manufacturing policy has shifted as they have attempted to move towards developed country status. The '*Vision 2020*' policy (see Section 5 for more details) aims to do this by increasing manufacturing productivity and expanding into more value-adding sectors. Five areas of significant industrial growth between 2009 and 2010 are shown in the table below[9].

Industrial growth area	Percentage growth
Semiconductors	56%
Audio-visual equipment	70.6%
Industrial chemicals	60.5%
Electronics and printed circuit boards	29.4%
Refined petroleum products	7.4%

Malaysia's key industry growth sectors

Foreign firms are attracted by the government's strong financial incentives and the country's location between '*East and West*'. Like Singapore, Malaysia's location and well-developed infrastructural networks make it a desirable manufacturing location, with the vast majority of its trade being exported from sea ports[10]. Since the mid 1980s, FDI, has moved from labour intensive manufacturing to more capital intensive manufacturing[11]. This is covered in more detail in Section 4.

Industrial development has largely been facilitated through the construction of purpose built industrial parks. The new sites are fully equipped with supporting infrastructure and the government has invested particularly heavily in high-tech telecommunications technology.

As well as having a larger population than Singapore, Malaysia also boasts a larger manufacturing workforce with almost one million employed as of January 2010[12]. Malaysian industry is represented at a government level by industry organisations such as the Federation of Malaysian Manufacturers (FMM)[13] and The Malaysian Industrial Development Authority (MIDA); they provide consultation, representation and lobbying on behalf of

Case Study: Chevron Phillips

Chevron Phillips Singapore Chemicals (CPSC) produces HDPE and was founded in 1980. The government's development of Jurong Island, combined with significant tax incentives at the time, acted as the catalyst for original investment.

The benefits of locating on Jurong Island were said to be excellent infrastructure, very close proximity to suppliers, and good strategic location for export to large markets. Potential challenges included relatively high energy costs.

Case Study: KHTP

Kulim High-Tech Park (KHTPP) is a technology park near Penang that hosts a number of manufacturers and research organisations around the microelectronics industry; tenants include Intel and First Solar.

KHTP aims to attract capital intensive investments from high-tech companies, promote and develop R&D, and develop an adequate pool of knowledge and skilled workers to meet the demands of industrial tenants.

Initial investments of RM2bn have attracted RM24bn from countries including USA, Germany, and Japan; expansion is still continuing. Benefits provided to companies include good logistical services, favourable geographical location, reliable infrastructure (e.g. data connection and a dedicated power station) and land for expansion.

Case Study: PNE Electric

PNE was established as a small PCB manufacturer in Singapore in 1976. Since then it has opened multiple factories in Malaysia and China and offices in the Netherlands and USA. It was listed in the Singapore Exchange in 1997 and in 2009 its revenue was over S$75M.

The Johor factory produces low to medium volume, relatively specialised electronic products; its largest customer is Philips. It was suggested that, as Chinese wages continue to rise, Malaysia's lack of minimum wage and stable pay make it increasingly suitable to FDI.

PNE have benefited from governmental tax incentives and training grants, and from improved infrastructure due to foreign investment.

Case study: SIMTech

The Singapore Institute of Manufacturing Technology (SIMTech) develops high value manufacturing technology and human capital to enhance the competitiveness of Singapore's manufacturing industry. It is a research institute of the Agency for Science, Technology and Research (A*STAR).

SIMTech comprises a number of research groups including Manufacturing Processes, Manufacturing Automation, and Manufacturing Systems.

Research has both practical and industrial elements, but industrial projects are the core constituent of student courses. Industrial links are supported by the fact that A*STAR is linked to the Ministry of Trade and Industry rather than the Ministry of Education.

Malaysian industry. The government's 2010 Budget has emphasised the need to strengthen the science and technology base. This was praised by the FMM for its efforts to liberalise the economic structure and encourage foreign investment through reduced tax rates (25% corporate tax).

Supporting information – Fuji Electric

Fuji Electric has invested nearly €100m in a plant in the Kulim High-Tech Park (near the state of Penang) which produces some 70% of Fuji's total capacity. Fuji has chosen Malaysia due to its '*…technically well-trained workers. Wage levels are slightly higher than in China or Vietnam but the quality of the English-speaking skilled workers is much better here. Besides the infrastructure is excellent…*' - Chong Nee Hwa, Fuji MD.

Source: 68 MWP – May 2009 Vol. 153 Issue 3, p14, "Made in Malaysia"

As with Singapore, Malaysian manufacturing is sensitive to falls in global demand due to the high proportion of its GDP derived from export; this has been evident recently through the impact of the global recession. The economy contracted by 5% in 2009, as exports of goods and services fell by 25.3% year on year, the steepest decline on record. The economy is expected to return to growth in 2010, with projections of 3.3%[14].

3.3 What role does R&D play in the region?

3.3.1 R&D in Singapore

R&D is an important area of Singapore's economy, with the country regarded as one of the top five innovators in the world[15]. R&D spending has steadily increased over the past five years and is projected to reach 3% of GDP by 2010, comparable to other developed nations[16]. R&D in new sectors is partly based on the experience and expertise of existing manufacturing sectors. For example, new research into clean energy and solar cells has been facilitated by experience in electronics, precision engineering and process automation[17]. However, the government also helps to promote certain new research areas, especially those that are in the national interest (e.g. water processing).

At the heart of Singapore's R&D developments is the Ministry of Trade and Industry's (MTI) 'Science and Technology Plan 2010'. The plan is being implemented by many government organisations and directly influences R&D expenditure.

One such organisation is A*STAR (Agency for Science, Technology and Research), Singapore's lead government agency for fostering world-class scientific research[18]. It coordinates public sector and academic research by providing support to other organisations (e.g. the Biomedical Research Council) and by promoting commercialisation of intellectual property (IP)[19]. Stringent IP policies[20], including strong deterrents against infringements[21], remain an attractive reason for companies to conduct R&D in the country.

Supporting information – Dell

Dell has moved its R&D for displays and imaging from Texas, to Singapore. The 3250m^2 facility is located at the International Business Park in Jurong. Dell CEO Kevin Rollins said: "*Singapore was chosen for the R&D centre because of it highly skilled and educated talent pool, pro-business environment, infrastructure, and sound intellectual property policies.*" Dell has four other design centres around the world in Taiwan, China, India and the US.

TSMC forecast industry rebound, IEE Review June 2005, Volume 51 Issue 6

The MTI's plan also addresses the need for educated graduates to conduct R&D. This is done by funding institutions (e.g. the National University of Singapore and Nanyang Technological University), reducing visa restrictions and providing student scholarships[22].

As with manufacturing hubs, designated R&D clusters have been established for companies to share facilities and resources. These research clusters enable companies, institutes and universities to work together, creating a 'culture of collaboration'[23].

Biopolis is a large hub for biomedical research[24], housing both international and local firms, including GlaxoSmithKline, Novartis, and several of A*STAR's research institutes. Fusionopolis is another hub, focusing on Info-communication Technology, Media and Physical Sciences and Engineering[25]. Both house shared resources including clean rooms, specialised wet and dry labs, and advanced instrumentation[26], and are located near several academic institutions including NUS, the INSEAD campus and the Singapore Science Park.

Biopolis and Fusionopolis provide strategic and practical benefits to companies both by the provision of shared facilities and the clustering potential of being located near critical suppliers and potential partners. The sharing of scientific equipment and infrastructure thus lowers the entry barriers for companies wanting to set up research operations in Singapore, and also reduces R&D costs and development time[27].

Supporting information – Novartis Institute for Tropical Diseases

Novartis, a multinational pharmaceutical company, founded the Novartis Institute for Tropical Diseases in partnership with the Singapore EDB as part of Biopolis. Novartis' reasons for basing R&D in Singapore were the availability of economic support, the provision of research facilities, the proximity to relevant [?] local diseases and a developing market potentially larger than the current western ones.

Asia Pacific Biotech News, 10(30, 2006, p163

3.3.2 R&D in Malaysia

Malaysia aims to reach 'developed country' status by 2020[28]. However, in order to reach this target, it will need to continue to transform itself into an innovative economy where competitiveness is not based solely on low-cost manufacturing using relatively unskilled labour. With this aim, the Malaysian government has been proactive in establishing policies and programmes designed to promote innovation, largely by encouraging active R&D. Most recently, this has included the Ninth Malaysia Plan (2006-2010) which aims to '*move the economy up the value chain, to raise the capacity for knowledge and innovation, and to address persistent socio-economic inequalities constructively and productively*[29]'. One government initiative designed to foster R&D is the offering of financial assistance through ministries and their agencies. An example of these grants is the

Case Study: NUS

The National University of Singapore is the oldest in Singapore and ranked 3rd in Asia in 2009. Research at NUS is closely aligned with both industry and government strategy; current major topics include Engineering in Medicine, Future Transport Solutions and Smart Sustainable Cities.

The EDB has recently been concerned by a decline in students wanting to read engineering. A programme is therefore underway to change the perception of engineering through education and outreach programmes.

International students comprise ~20% of undergraduates and 65% of postgraduate places. The number of exchanges (to attract students to Singapore) is constantly increasing including a new exchange with University of Cambridge (in collaboration with Shell).

Case Study: GSK

The GSK R&D facility at Biopolis employs around 50 people, with an equal mix between of local and overseas staff. The close proximity of several research facilities allows for effective collaboration; e.g. access to suppliers, sharing certain resources with competitors, and access to academic partners.

The GSK Jurong manufacturing plant is also nearby and manufactures pharmaceuticals for the treatment of asthma, hepatitis B, HIV, peptic ulcers, migraine and skin disease. The Singapore plant is particularly important being one of only two global locations for new product introduction (the other being Cork in Ireland). To aid in this, the site also has testing facilities for late stage development, and close links with the above research facilities.

Case Study: Algaetech

Algaetech, located at Technology Park Malaysia in Kuala Lumpur, is one of a group of six companies working to utilise algae, developed in the US, to address local industrial requirements.

Their R&D facility is working on applying algae to the sequestration of CO2, treating slurry from palm oil processing, and the manufacture of pharmaceuticals.

Key challenges faced by the company include lack of knowledge of potential collaborators and difficulties taking advantage of cluster benefits of the technology park.

Ministry of Science, Technology and Innovation (MOSTI) administered *TechnoFund*. This fund aims to support the commercialisation of basic research, specifically targeting Malaysian companies[30]'. Products eligible for the *TechnoFund* must lie in one of four technology clusters: Biotechnology, Agricultural, ICT and Industrial (e.g. advanced materials and manufacturing).

The Malaysia government also encourages technology transfer by helping to establish links between large firms (particularly MNCs) and local SMEs, who act as their suppliers. The expectation has been that these links will enable SMEs to benefit from any technical assistance and training provided by larger companies. However, the influx of MNCs during the FDI boom of the 1980s and early 1990s did not result in the degree of technology transfer expected. In fact, although Malaysian companies were often able to improve their existing operations, few moved on to activities such as design or high-level R&D; these higher-value activities have remained with the MNCs themselves[31]. One programme that aims to target this problem is the SMIDEC[32] Industrial Linkage Program (ILP), which encourages effective partnerships between SMEs and larger scale companies.

The Malaysian government also provides support to encourage universities and public research institutions (PRI) to collaborate with firms to commercialise research. However, a government survey of 5,232 research projects carried out during the 1990s in PRIs and universities found that '*only 5.1% have resulted in commercial applications*'[29]. In order to improve these links, the Malaysian government has set up several initiatives, including the Technology Development Cluster Program. This programme aims to develop a cluster of high technology companies as an incubation centre, operating within and collaborating with universities and PRIs. Each incubation centre has a specific focus that reflects the four key industries targeted by Malaysia, as outlined above.

R&D does, however, require a suitably experienced workforce of which Malaysia has a recognised shortage. Specifically, Malaysia lacks '*engineering and science graduates, and needs a tenfold increase in science and engineering graduates as a proportion of the populace to achieve the same levels found in Singapore, South Korea and Taiwan*[29]'. This perception was supported by some companies visited and graduates were felt to leave university with insufficient or inappropriate skills for employment. In order to counteract this human capital deficiency, the Malaysian government aims to strengthen the formal education system through a series of reforms[33]. By 2020, the Malaysian Higher Education Strategic Plan aims to have 100 researchers, scientists or entrepreneurs per 10,000 members of the country's labour force[34].

3.4 Manufacturing and R&D capabilities - conclusions

Singapore is concentrating increasingly on using its advanced logistics network, favourable location and high availability of educated labour to attract high-value manufacturing. Its success serves as a good example of a country using limited resources and a small domestic market to its advantage by focusing on export. By developing dedicated industrial parks, they have also made best use of limited space to provide companies with clustering opportunities to target efficient resource use and knowledge sharing benefits.

In contrast, Malaysia has more natural resources, which have acted as a platform to grow successful primary processing and low-wage industries.

Malaysia is striving, however, to move beyond being seen as purely a low-cost manufacturing hub. As a result, in a bid to reach developed country status by 2020, focus has recently shifted to encouraging manufacturing as a tool for development, by increasing productivity and expanding into more value-adding sectors (e.g. semi-conductor processing). While Malaysia's primary focus is on developing Malaysian-based companies, they have also followed a similar strategy to Singapore by attracting foreign companies in order to grow internal expertise.

Both countries see R&D as a means to maintain and expand their manufacturing industries. Singapore has been recognised as one of the top five innovators worldwide while Malaysia aims to emulate this success and use R&D to reach developed country status. In both countries, government policy attempts to establish a framework in which this innovation can take place by championing certain sectors and providing support to R&D focused firms. Similar companies have been encouraged to cluster together in science parks (e.g. Biopolis in Singapore and Technology Park Malaysia in Kuala Lumpur) to promote knowledge transfer and to share facilities.

During the course of the case interviews with companies in both countries it became apparent that there were widely differing views within the region on the relevant skill level of graduates from national universities in both countries. In general, the skill level in Singapore was deemed appropriate to the country's manufacturing and R&D activities, with strong industrial and government involvement in course programmes at NUS and NTU. In Malaysia, by contrast, there was the perception, especially amongst foreign MNCs, that graduates were relatively under-skilled with respect to the requirements of their industry (especially semiconductors and related technologies). One of the reasons appeared to be that in Singapore senior industrialists are involved in university advisory committees, shaping course structures to match the needs of the labour market; such links between industry and academia do not appear to function as effectively in Malaysia.

Case Study: University of Malaya

To ensure that its graduates have sufficient skills or knowledge for industry requirements, UoM has taken a number of actions. To ensure the quality of its output, each undergraduate course is scrutinised by the Engineering Accreditation Council (EAC), by a panel of industrialists, professors and foreign experts. If approved, the course is endorsed by the Institute of Engineers, Malaysia (IEM) and is consequentially recognised by all other international signatories of the Washington Accord (including the UK, USA and Canada). The curriculum is reviewed every three years in an attempt to address the changing issues faced by industry.

Also, to retain some of the brightest students in the country, UoM has a "Bright Spark" programme which seeks to keep the brightest students within the UoM faculty following completion of their undergraduate degrees.

4 The development of FDI and local industry in the region

4.1 Introduction

Government policies and interventions have had a significant effect in both Singapore and Malaysia on the actions and decisions made by companies. In order to understand the development of local industries and the encouragement of foreign direct investment (FDI) in the region, it is important to consider the attitudes and strategies of governments towards both. It is also necessary to take into account the impact of Singapore and Malaysia's different cultures which have implications for international companies' operating in the region. In particular, the differences in attitudes compared with Western countries need to be understood.

As in any country, the relationship between developing local industry and encouraging foreign investment is complex and multidimensional. It was decided to break the topic down into three key areas of research: government development of local industry, the regulatory environment for foreign companies, and cultural/societal considerations of operating in the region[ii].

4.2 What are the government strategies for developing local industry?

4.2.1 Singaporean government strategy

Singapore focuses on innovation investments in a 'core' of industries, currently aiming to grow SMEs in the areas of life sciences, clean technology and digital media (as discussed in the previous section). Companies conducting business and research in Singapore often receive tax relief, benefit from state-of-the-art infrastructure, training for technical staff, and some can even qualify for research grants covering up to 40% of expenses. Biopolis and Fusionopolis are clear examples of the government's support in action.

The Singaporean government encourages SMEs by offering support through organisations and initiatives such as the Standards, Productivity and Innovation Board (SPRING Singapore), its SPRING Start-up Enterprise Development Scheme (SEEDS), and the Special Risk-Sharing Initiative. The first aims to assist SMEs through financing, capability-building and encouraging a pro-enterprise culture; it was anticipated that up to S$2.3bn (£1.1bn) in loans would be generated in 2009.

SPRING SEEDS is an equity-based co-financing option for Singapore-based start-ups creating innovative products and/or processes, possessing strong growth potential across international markets. SPRING SEEDS Capital also invests in commercially viable start-ups and matches dollar-for-dollar by third-party investors[35].

Finally, the Special Risk-Sharing Initiative (started in December 2008) was recently extended to January 2011. The scheme was devised to support SMEs seeking funding during the economic downturn and involves the government taking on a significant proportion of risks for loans. Thus far, the scheme has supported some S$8.0bn (£3.8bn) worth of loans in 2009, (5.5 times greater than 2008) and, according to the Ministry of Trade and

Case Study: SAESL

Incorporated in 1999, Singapore Aero-Engine Services Ltd (SAESL) is a S$185 million joint venture between Singapore International Airlines (SIA) (50%), Rolls-Royce (30%) and Hong Kong Aero Engine Services Limited (HAESL) (20%). It specialises in the MRO of Rolls Royce Trent aero engines.

Rolls-Royce contributes approximately 0.3% of Singapore's GDP. As a consequence, the government provides support and incentives to encourage Rolls-Royce's activities and to develop the aerospace industry. Key involvement includes paying aerospace graduates during the recession to maintain recruitment, tax incentives, R&D funding and grants for technology firsts.

[ii] Note that in this research only inbound FDI is considered. Whilst recognising that outbound FDI is of considerable importance to both Singapore and Malaysia, the study of this topic is outside the scope of this report.

Industry, the government expects to support S$8.4bn (£4.0bn) in new loans in 2010.

It is also worth mentioning that the Singaporean government is currently helping Singapore-based companies to develop their international markets. Government backed organisations such as International Enterprise Singapore (with a budget of over £100m)[37], aim to help local companies to gain access to key markets such as China, India, Southeast Asia and the Middle East.

The range of supporting programmes offered by the Singaporean government are possible because of its strong financial position and clear approach to supporting specific technologies which it sees as strategically important.

4.2.2 Malaysian government strategy

Developing its own successful industries and national companies has been an important aspect of Malaysian economic policy since the early 1970s. During this development, the Malaysian government has traditionally protected and encouraged the wealth of Bumiputera, indigenous Malaysians. There have, for example, been Bumiputera equity requirements (30%) for publicly listed companies; however these requirements were removed in 2009. Instead, heavy industries such as iron, steel and petrochemicals (which generally have high Bumiputera participation) have been the subject of recent government measures designed to enhance their local competitiveness[38].

Recently, the Malaysian government has also moved to protect certain industries during the global economic downturn. For example, Malaysia is an important regional producer and exporter of automotive parts, components and accessories to companies such as Mercedes, Ford and Mazda. Initiatives have therefore included an allocation to the Automotive Development Fund[39], excise tax refunds for domestic automakers[40] such as Proton, and assistance for import duty exemptions on raw materials, components and capital equipment.

Malaysia also supports local industry through government-backed private equity funds. Examples include Proton car manufacturer, the major shareholder of which is the government. Ekuiti Nasonal Berhad, which was established in 2009 to promote equitable and sustainable Bumiputera economic participation, also helps existing medium-sized businesses and entrepreneurs grow their businesses in a sustainable way[41]; an example is the Malaysian Technology Development Corporation (MTDC), set up in 1992 to spearhead the development of technology businesses. Although initially concentrating on the promotion and commercialisation of local research and bringing in new technology from abroad, MTDC has become a leading venture capitalist in the country[42].

As previously mentioned, the Malaysian government is trying to move exports up the value chain from raw materials processing to the manufacture of higher-value products. An example of this was the creation of the Multimedia Super Corridor (MSC), which aims to attract both local and foreign investment (originally in the ICT sector). Whether local or foreign, companies hoping to gain MSC status must demonstrate '*strong value propositions specifying how operations will contribute to the development of the MSC and Malaysia*'[43].

Case Study: Proton

Proton was created in 1983 as part of the national car project. The company has developed into an integrated car operation (including design, manufacturing, sales and after-sales) with a developed and strong local supplier base.

Proton was created to satisfy three main aims: to spearhead the industrialisation of Malaysia through the automotive sector, to acquire local technical skills (enabling a spillover effect into other manufacturing sectors), and to strengthen Malaysia's international manufacturing competitiveness.

Proton's further development has been aligned with Malaysia's industrial master-plan. The period between 1986-1995 was focused on initial manufacturing competency, between 1996-2005 this changed to the design of the cars, and from 2006 to the present day efforts are being focused on transforming Proton into a globally competitive automotive company.

Although officially the government does not have a controlling share in Proton (owning only 42%), the 18% owned by Petronas (who are strongly aligned with the government) means that Proton is essentially nationalised.

4.3 How can international companies benefit from the regulatory environment in Singapore and Malaysia?

4.3.1 Regulatory environment in Singapore

Singapore has a "pro FDI" stance on encouraging investment. According to a recent report on globalisation and the changing world of business[44], Singapore was ranked as being the most globalised nation. Ernst & Young Partner, Steven Phan, also praised Singapore for its "long-standing commitment to operating a free and open economy, underpinned by its dual-pronged strategy of attracting foreign investments and talents"[45].

Case Study: Shell

Shell's history in Singapore extends back almost 120 years, however the Bukom refinery was the first major investment in 1961. Since then, major investments have been completed almost every decade including the addition of hydrocrackers, and a long-residue catalytic cracking unit. Most recently, the Singapore Eastern Petrochemicals Complex (SEPC) marked Shell's largest ever global petrochemicals investment as the site achieved complete integration.

The attraction of making such large investments is predominantly due to government support. Corporation tax relief for high-technology investments was cited as one of the biggest incentives along with excellent infrastructure and logistical networks. Shell maintains close relationships with the government to ensure clear communication concerning future investment decisions.

The importance of exports to the Singapore economy has already been highlighted with 60% of GDP being accounted for by exports[46]; forging free trade agreements and resisting protectionism are therefore fundamental parts of the country's economic policy. According to George Yeo, Singapore's Minister for Foreign Affairs:, "*an important item for Asia Pacific Economic Corporation is the proposal to establish a Free Trade Area of the Asia Pacific region as a long-term goal.*"[47] The Singaporean government has thus, to date, committed the country to signing 19 bilateral free trade agreements (including one with the European Free Trade Association). With regards protectionism, Business Monitor International gave Singapore a rating of 100 (the best possible score)[48]. However it is worth noting that foreign participation in certain industries is restricted; examples include armament manufacturing, domestic media, and broadcasting[49].

Alongside trade, FDI is an important aspect of the Singaporean economy, accounting for approximately 70% of total investment in Singapore[48]. Attracting greater inward FDI flows (especially in their 'core' industries) is therefore a priority and has resulted in pro-business policies to make it easy for corporations and individuals to do business in Singapore[50]; examples include the Global Investor Programme (GIP), the Multiple Journey Visa and the Long-Term Visit Pass for Entrepreneurs (LTV).

In addition to the above, ease of FDI is also dependent on a country's legal system and Singapore is perceived to have one of the most transparent and efficient in the world[51]; it was ranked first in terms of the ease of doing business in the World Bank's "*Doing Business 2010*" report. Singapore is not totally devoid of corruption and economic crime, however. Whilst less than most Asian countries, PwC's 'Global Economic Crime Survey 2007' suggested 19% of companies operating in Singapore had been the victims of economic crime within the two previous years; IP infringement, money laundering, corruption and bribery were quoted examples[52].

Supporting information – Tax in Singapore

	Singapore	United Kingdom
Corporation tax	17%	28%
GST/VAT	7%	17.5%
Capital Gains Tax	No	Yes
Maximum income tax rate	20%	50%

The table above shows that tax rates in Singapore are more favourable than those in the UK which may attract foreign investment to Singapore.

Tax Facts and Figures, 2009 Singapore, PriceWaterhouseCoopers

Finally, while FDI in Singapore gradually increased until 2007, the recent global economic downturn has had a noticeable effect. This is to be expected; historically, weaker performance in the world's most advanced economies has led to lower FDI in Singapore (see table below). The most important sources are the US, Netherlands, UK and Japan[48], and recent FDI has been concentrated in the Financial Services, Insurance, and Manufacturing industries[53].

Supporting information – Foreign direct investment inflows

	£ mn - current prices – fixed 2009 exchange rates				
	2004	**2005**	**2006**	**2007**	**2008**
Malaysia	3196.9	2799.8	4044	5254.1	4887.2
Singapore	14942.5	10547	19389.3	20962.1	14174.1

Foreign Direct Investment Inflows: UNCTAD. Date exported: 10 Aug 2010
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4.3.2 Regulatory environment in Malaysia

Malaysia adopts a more protectionist stance than Singapore, but a growing awareness of the importance of FDI to Malaysia's economic development has led to both a number of pro-FDI initiatives and to the relaxation of laws that have historically inhibited FDI (e.g. the removal of equity ownership laws for ethnic Malays).

The table above shows the recent trend in FDI[9] in Malaysia. Although it has increased since 2003, it is still much lower than in Singapore and, like its neighbour, the 2008 economic downturn negatively impacted FDI. Looking further into the past, Malaysia has also dropped down the global FDI rankings in absolute terms[54] from 6th in 1995 to 62nd today. One of the principal reasons for this change is the increasing competition from other low wage Asian economies; for example, several large MNCs (Motorola, Seagate and Solectron) have shifted production from Penang to elsewhere in Asia[48].

As manufacturing now accounts for over 50% of Malaysia's FDI, regulatory changes in recent years have aimed to maintain or grow this percentage. Incentives are focused on specific sectors and investment in biotechnology, for example, is promoted by various tax and import duty exemptions[55]. These incentives are prescribed at a federal level whilst states offer practical packages such as provision of labour or infrastructure.

Supporting information – Bill of Guarantees

In order to ensure the success of the MSC Malaysia companies, the government promises to fulfil a 10 point Bill of Guarantees. Their promises, some of which are particularly encouraging for foreign firms, include:

- Allowing unrestricted employment of foreign knowledge workers
- Exempting MSC Malaysia status companies from local ownership requirements
- Providing competitive financial incentives, including exemptions from paying income tax for up to 10 years or an investment tax allowance, and no duties on import of multimedia equipment
- Becoming a regional leader in IP protection and cyberlaws

www.mscmalaysia.my

Case Study: Intel and Osram

Intel and Osram were two of the original "7 Samurai" that located to Malaysia in the early 1970s due to its attractiveness as a low cost manufacturing region.

Today, both contribute significantly to the economy of Malaysia and continue to grow due to the robust local infrastructure, strategic location and support mechanisms in place from the regional (Kulim and Penang) and national governments. Key challenges remain in recruitment of qualified local graduates and in resource retention.

Case Study: Invest Penang

Invest Penang was established in 2004 as a non-profit entity of the state government to sustain, rejuvenate and further promote business activity in Penang.

Of the 227 MNCs operating in Penang none are British. The countries with the largest number of investors are Taiwan (58), Japan (53), USA (40) and Singapore (25).

Along with having very competitive electricity and water rates, Penang also benefits from low, monitored inflation and high worker productivity. The cost of production in China has risen and so Invest Penang is trying to advertise Malaysia as an honest and open investment opportunity with no hidden costs and aid for investors wherever possible.

Case Study: Dell

Dell currently has 3 plants in Malaysia and the Asia Pacific Japan (APJ) segment provides around 12% of the total group's income. In 2007 Dell contributed approximately 7% of Malaysian national GDP.

Geographically the country is located centrally within the region, with efficient transport links being provided by numerous sea and airports. The region is also home to a number of original "Samurai" international IT companies including Intel and Seagate; advantages of locating in Penang therefore included being close to critical suppliers. These companies have helped to support the development of strong supply-chain capabilities including infrastructure and logistic service providers.

Dell received "Pioneer" status upon locating in Malaysia. This status provides a 10-year exemption from corporate tax. Further government-based support included trade incentives, subsidies and rebates if certain criteria were met. When importing and exporting within the Free Trade Zone (FTZ), taxes are waived and other incentives include subsidies to offset costs of transportation.

Other sectors, however, are more restricted. In the oil and gas industry, all foreign energy investment is conducted through production sharing contracts between foreign operators and Petronas (Malaysia's national petroleum company). Non-Malaysian firms are only permitted to participate in oil services either in partnership with local firms or as contractors[56]. Foreign ownership restrictions also still exist in many other sectors, including telecoms, shipping and insurance[48].

The Malaysian government has been keen to make FDI relatively straightforward and several agencies exist to provide support. For example, the Malaysian Industrial Development Authority (MIDA) acts as a first point of contact for investors interested in setting up manufacturing projects in Malaysia. MIDA can advise on government policies and procedures and provide assistance to companies by liaising with relevant authorities and institutions[57].

The efforts by the government have meant the World Bank ranked Malaysia 23rd in the world for overall ease of doing business. It was first in terms of the ease of 'getting credit', and fourth for 'protecting investors'. However, it was ranked very low for 'dealing with construction permits' (there are a large number of procedures and the process is lengthy), and for ease of 'starting a business'[58]. This suggests that bureaucracy may be one of the barriers to greater FDI inflows.

There are other major factors which may act as barriers to FDI; the regulatory environment in Malaysia, taxation levels, and the availability of labour:

1. The lack of transparency in government decision-making procedures in Malaysia has served to impede foreign firms' access to the Malaysian market. Malaysia has slipped in its ranking on Transparency International's corruption perceptions index from 33 in 2002 to 47 in 2008[59]. The legal system is subject to political influence and there is a perception amongst some that doing business in Malaysia will always, to some extent, rely on dealing with the politically connected. Some companies suggested that 'financial leakage' was not unknown during large projects. It was implied that political connections were sometimes important and also that favouritism (beyond that formalised by law) towards indigenous Malays was sometimes present.
2. The standard rate of corporate tax is currently 25%, higher than in Singapore, but marginally lower than in the UK The VAT equivalent (Sales tax) is at a standard rate of 10% (again higher than Singapore) [48].
3. Malaysia has a shortage of highly qualified professionals, scientists and academics. [iii]Penang, for example, missed out on a multibillion dollar investment by a Western electronics company in 2009 because it could not guarantee that it could provide a sufficient number of qualified engineers[60]. Some industrialists have raised concerns over the quality of the Malaysian education system, both in schools and universities[61]. Making employees redundant is significantly more difficult and costly than in other Asian and OECD countries according to the World Bank[62] and the government also monitors the hiring practices of foreign employers who must meet guidelines designed to ensure a racial balance in employment[48].

[iii] Whilst this may be regarded as a concern for foreign companies wanting to locate high-tech research or design functions in Malaysia, it may also be interpreted as a positive example of the degree of openness and honesty in dealing with the Malaysian authorities.

4.4 What features of culture and society affect international companies operating in the region?

4.4.1 Singaporean culture and society

The Singaporean government has actively been encouraging social cohesion for many years, in part through its social housing programmes. Combined with an increasingly diverse population (as a '*gateway to the east*'), the Singaporean culture is not as strongly knit as that of Malaysia. It is, however, well known for its cultural heritage of Kiasu. Kiasu can be defined as an "*obsessive concern with getting the most out of every transaction and a desire to get ahead of others*" [63]. It can be viewed as a cultural negative with the government frequently running "courtesy campaigns" highlighting how members should avoid practicing bad Kiasu. It is, however, also viewed as a cultural positive. Recently Wong Kan Seng, Minister for Foreign Affairs, argued that Kiasu is really just a way of describing a Singaporean's drive for excellence and, in the "Lion State" of Singapore, where entrepreneurial drive is emphasised, it should only be encouraged.

The concept of 'face' is also an important aspect of Singaporean culture. 'Face' is a superficially simple concept which may be interpreted as the prevention of embarrassment at all costs. A Singaporean's 'face' plays a significant role in the world of business and it is important never to make him or her feel ashamed or embarrassed. For example, an employee would not disagree with his superior in public and would never raise his voice in an argument; this would cause a loss of 'face' for all involved. In companies visited, this concept of face was often seen as one of the hardest cultural aspects to overcome. Workers, or business partners, may not give their true opinion because they feel they are preserving the other's face, yet this can easily frustrate the unwary international manager.

In recent years many authors have remarked upon the success of Singapore in attracting foreign companies into the country. This success is thought to be largely due to Singapore's strong governmental control, by which the country's progress is closely monitored. The active strategy of the government has been to create a modern country of disciplined, hierarchical, and authoritarian appearance, capable of quickly adapting to the needs of multinational corporations. [64] This technocratic model of culture however has been criticised for diminishing the country's ability to produce the creative and innovative workers required for its knowledge economy. This level of governmental control can also create conflict as the democratisation of access to information stands in direct opposition to the Singaporean government's control over what, and how much, information its citizens receive.[65]

Another key trend of interest to foreign companies is the growing influence of women in managerial roles. This is due in part to MNCs as well as the spread of public education, delayed marriage, declining fertility rates and the rise in dynamic entrepreneurialism of women[66]. Until recently, organisations have primarily provided low-level employment for female workers, however intensified global competition is forcing firms to make better use of women[67]. The female participation rate of Singapore is now one of the highest in the world at 56.73%,[68] with female workers being better educated than their male counterparts (60% compared to 48% of males hold at least secondary qualifications)[67]. Despite this, the number of women occupying executive or managerial roles remains low. In the working environment only 23% of decision-making roles (legislators, senior official and managers) are occupied by

Case Study: Staff sourcing

It was very noticeable during company visits that companies had varying staff sourcing policies, often depending on the industry.

Manual labourers were often of foreign origin on relatively short-term contracts. At Sembawang Shipyard the majority of manual workers were of Bangladeshi, Indian and Chinese origin (outnumbering local employees 5 to 1). Many workers quickly moved on after training, a problem faced by many Singaporean companies where average monthly turnover is 2%.

However, a large MNC had different staff turnover levels; a significant proportion of employees had worked there in excess of 20 years. This firm had a policy of maintaining one expatriate plant manager, with all other staff being Singaporean; the relationship between both parties appeared good.

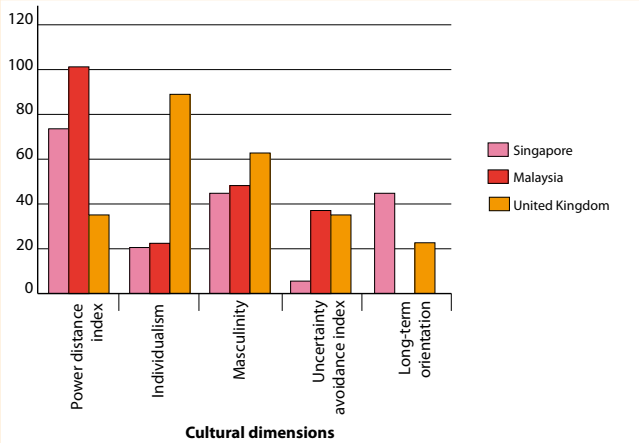
Finally, another MNC commented on the differences between the well-educated workforce and temporary contractors. The former worked well in multi-national teams (with the majority remaining Singaporean) whereas poor language skills and limited education caused problems amongst foreign manual labourers.

women. This disparity has been attributed to cultural and religious beliefs where women are not viewed as authoritative figures or business decision makers; these views are slowly changing however.

Supporting information – cultural dimensions

One way to compare the two countries' working cultures is to use Geert Hofstede's research[1] into how values in the workplace are influenced by culture (see Figure 1). Hofstede's study demonstrated that there are national and regional cultural groupings that affect the behaviour of societies and organisations, broken down into 5 main cultural dimensions, from which selective comparison between Singapore and Malaysia is possible, referenced to the UK. Although Hofstede's conceptualisation of culture as static and essential has attracted some criticism[2] it can still act as a very useful tool and replication studies have yielded similar results, pointing to stability of the dimensions across time.

Singapore and Malaysia ranked very highly on Hofstede's Power Distance Index[3], both coming higher than the UK. Overall this means that an unequal distribution of power throughout the organisation is more likely to be accepted by the less powerful members of organisations. This can often manifest itself through members of the team wanting stronger powerful leadership. Malaysia ranked higher than Singapore indicating that its culture places a greater importance on hierarchical structure and clear recognition of social differences. As such, centralised authoritarian management styles are more prevalent than in the West. Malaysians tend to prefer to operate in structured environments where rules and expectations are clearly stated. This may limit the extent to which flexibility and empowerment can be implemented.



Geert Hofstede's cultural dimensions

Singapore is much lower on the Individualism Index than the UK[3]. In Singapore, individuals are likely to be integrated into strong, cohesive in-groups. Traditionally firms practice the idea of cooperation amongst group members to maintain overall group harmony. Teamwork is seen as the main way of achieving company goals (and group harmony). Additionally Singaporean family groups will include extended families of uncles, aunts and grandparents, which will protect them in exchange for unquestioning loyalty. By comparison, in the UK an individual is only expected to look after themselves and perhaps their most immediate family. Companies need to be aware therefore that in Singapore family occasions can often take precedence over work, and that workers are likely to prefer tighter knit communities at work with team reward and responsibility rather than individual praise. The younger generation, however, tend to follow more western values, often exhibiting more individualistic traits.

[1] Hofstede, Geert; Hofstede, Gert Jan (2005). Cultures and organisations: software of the mind (Revised and expanded 2nd ed.).

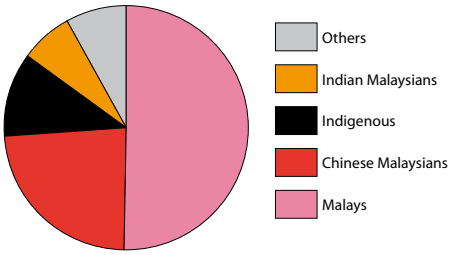
[2] Ailon, G. (2008). Mirror, mirror on the wall: Culture's Consequences in a value test of its own design.AMR, 33(4):885-904

[3] http://www.geert-hofstede.com

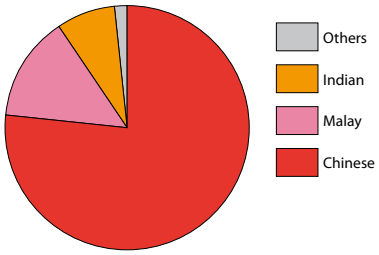
4.4.2 Malaysian culture and society

Both Malaysia and Singapore have strong cultures arising from the countries' unique histories. In broad terms the Malaysian national culture is based on the indigenous Malay[69] whereas Singapore has more pronounced Chinese and British influences. In fact, any Muslim prepared to follow Malay culture may qualify as an ethnic Malay should they wish (a status which receives several financial advantages), and the statistics (see graphs [70] [71]) give little indication of the true multicultural feel of the main cities.

Ethnic groups in Malaysia



Ethnic groups in Singapore



Traditionally, the ethnic Malays have been the poorest social group in Malaysia and past government policies have taken steps to rectify this. These achieved some success and Malays have now overtaken Indians in wealth. However, this has led to increased racial tensions whilst only benefiting a small proportion of the population. These pressures, and a feeling that equity requirements were impeding foreign investment, have led to a move away from affirmative action and the equity requirement has been removed.

As a result of the previously discussed mismatch between university courses and the job market, approximately 60,000 university graduates were unemployed in 2009[72]. The government therefore plans to restrict foreign workers to increase the number of jobs available to Malays. The one exception to this is knowledge workers where there are no restrictions; this is driven by a perception that there is a shortage of home-grown Malaysian knowledge workers, especially engineers. This is partly attributed to the Malaysian school system, which places greater emphasis on memorising than on problem solving ability. In recent years, there has also been a switch from teaching in English to establishing vernacular schools for Malays, Chinese and Tamils. This has been criticised as undermining social cohesion, made worse by the Malaysian government's overseas scholarships being awarded largely to Bumiputera[73].

Malaysia's management practices are becoming increasingly westernised, but key cultural and religious beliefs and values still have a strong influence on Malaysian managers and their leadership styles. There is an emphasis on loyalty and cohesion within work units, and on humane treatment of employees[74]; assertive or confrontational behaviour is discouraged. Although the government supports the full and equal participation of women in education and employment this is not always reflected in the available statistics. Women make up 50% of university graduates, yet are still under represented in the workforce and there are few sexual harassment laws. In 1999 the government launched a voluntary code aimed at reducing sexual harassment in the workplace. However, this has not yet become law and legal redress exists in only a few companies. Those most at risk tend to be unmarried, less educated Malays[75], and a lack of emphasis on increasing gender egalitarianism indicates that women may well continue to have problems moving into senior positions[76].

Case Study: Dyson

Dyson is a privately owned consumer goods manufacturer with a portfolio of 33 products of three product types: vacuum cleaners, fans and hand-driers.

Dyson employs 480 people in Malaysia (of which 340 are engineers) with 20 expatriates. However, to support expansion, Dyson have an ambitious hiring plan having hired 50 engineers in the last year (predominantly from Malaysian universities).

Engineers regularly participate in secondments to the UK (and vice-versa) so that all staff understand aspects of both new product development and manufacturing. The need for flexible work permits was cited as one of the key company requirements from the Malaysian government.

4.5 FDI conclusions

It has been shown that the governments of both countries play an important and active role in determining the balance between developing local industries and encouraging foreign direct investment. There are some similarities in their approaches to this relationship. Both governments are interventionist in comparison with the UK, and implement policies to promote or protect specific industries. Singapore has established research facilities, such as Biopolis and Fusionopolis, in order to promote specific industries whilst supporting its SMEs through well-funded financing programmes. Similarly, Malaysia has provided fiscal incentives to attract high-tech industries, both local and foreign, and has assisted the development of a number of technology and science parks.

However, despite the close geographic proximity of the two countries, there are fundamental differences between their attitudes to local and foreign investment. Singapore is a trade dependant country and consequently aims to maintain a free economy by encouraging free trade agreements and resisting protectionism. They have been ranked first in the world in terms of the ease of doing business, with tax and legal systems that are attractive to foreign investors. In contrast, Malaysia is more focussed on protecting local industries, and in particular protecting the interests of indigenous Malays. Foreign participation in certain industries is restricted and traditional local industries such as iron, petrochemical and automotive are encouraged and protected. The regulatory environment is thus less conducive to doing business with bureaucracy and political complexity sometimes being problematic.

A number of cultural factors that would need to be considered by western countries operating in the region have been identified. In both countries, the concept of 'face' is important in the relationship between employers and employees. The drive for excellence, Kiasu, is also significant, affecting the attitudes of Singaporeans towards their work. In Malaysia, the quality of the education system and a shortage of knowledge workers could affect the ability of western companies to find the labour that they need. The historic preferential treatment of ethnic Malays is also a key cultural consideration, although recent governments have removed some of these policies. Analyses of cultural dimensions have indicated that both Singapore and Malaysia place greater importance on social status, hierarchical structure and team working than the UK. These key cultural beliefs continue to have a strong influence over leadership styles, despite an increasing trend towards westernisation.

Finally, from the case interviews conducted, it became clear that in Malaysia the influence of the state government was at least as strong, if not stronger, than that of the national government. Penang has been historically successful in attracting investment due to the guarantee of resources and infrastructure, whilst being honest and transparent with the foreign companies concerned, so that they do not over-commit on deliverables. In KL, there was more evidence of privately funded VC activity, especially within the science and technology parks, and also tighter restrictions on foreign investments especially where there were cultural implications (for example in the brewing industry).

5 What are the drivers of green and sustainable technologies, policies and practices?

5.1 Introduction

Addressing the global sustainability[iv] agenda has been described as one of the greatest challenges of the coming decades. There is a growing understanding that the combined pressures of rapidly expanding population with increasing expectations of standards of living are mutually incompatible.

It is widely recognised that industry has been a major driver in raising quality of life around the world, however it is also understood that manufacturing systems, and their products, influence the deterioration of the global environment; some experts suggest that industry can account for more than 30% of greenhouse gases in industrialised countries. Businesses and governments are thus beginning to react and are commonly reporting sustainability issues in terms of the environmental, economic and societal impact (increasingly referred to in literature as the Triple-Bottom Line).

Given the importance of the sustainability agenda, this research project considered how both global and local pressures are affecting the region. Like so many countries, both Singapore and Malaysia realise that they will be affected by the global reaction to sustainability, and are thus seeking to benefit from changing opinions and practices.

In order to understand the effect of such pressures on Singaporean and Malaysian businesses, it is necessary to consider three key questions. Firstly, what internal and external factors influence and drive interest in sustainability in the region? Secondly, what government initiatives and policies have been implemented (including both intent and impact)? Finally, by considering the development of key technologies and industries in both countries, the impact of the previous two questions can be assessed.

5.2 What are the drivers for sustainable development in Singapore and Malaysia?

5.2.1 Singaporean sustainability drivers

'Sustainability' in Singapore has historically been considered as the sustainability of the city itself (in terms of both resource usage and the island's habitability). Singapore lacks natural resources therefore efforts are being made to reduce consumption and increase efficiency to decrease dependence on imports. Habitability issues include efficient use of space, air quality and pollution. Concern about climate change has only recently become prominent when the government committed to deal with CO_2 emissions in the 2006 update to its Green Plan.[77]

Whilst Singapore's strategic direction (and therefore its attitude to sustainability) is predominantly driven by government initiatives, it is important to consider pressure from the local population. Eighty-four per cent of Singaporeans claim to have 'some' knowledge of climate change

[iv] The definition of Sustainability used in this report is that of the Brundtland Commission of the United Nations (1987); "*Meeting the needs of the present generation without compromising the ability of future generations to meet their own needs.*" The term 'green' is used to mean those products that contribute towards a sustainable lifestyle or use of resources.

Case Study: MNC Standards

A common theme amongst MNCs was the adherence to global ISO standards; e.g. Shell quoted ISO 14001, 9001 and 18001 when asked about international standards.

A recurring 'principle of operational standards' was that MNCs would consider their own internal standards and those of the Singaporean government and then follow the most stringent.

Some companies implied that internal levels were often higher than national requirements and that Singaporean rules were regularly less stringent than those of Europe or USA. Exceptions to this usually related specifically to Singapore as a small island; e.g. the NEA's smoke limits and water usage.

Case Study: Intel

Intel's site in Penang was its first outside the USA. It prides itself on being one of the greenest companies in the electronics sector and its environmental policy is driven by corporate strategy (e.g. its current work to reduce the power consumption of its servers).

The company is working to improve its environmental impact at every stage including R&D, materials, using approved chemicals, operations, products and end of life management. In addition, the firm sponsors numerous recycling events and environmental education events.

It was even suggested that Malaysia's lower environmental standards sometimes hinder Intel's efforts to improve their operations, as they are unable to source certain consumables (e.g. diesel) at their required standard.

with 44% believing it to be the result of human activities (equivalent percentages amongst Malays are 71% and 63%)[78].

A recent paper on corporate attitudes to sustainability found that large, export-driven, foreign-owned companies were more likely to have defined or implemented environmental protection measures (often as a result of international standards and requirements e.g. ISO-14000). A similar situation was observed by the team whilst on visits. Anecdotal evidence suggested that the Singaporean government had recommended to one company that it should delay investment in additional pollution-controlling equipment; the government wanted to avoid a short-term reduction in corporation tax income due to investment in '*unnecessarily high*' environmental standards.

Most pollution control measures are 'end of pipe' technologies rather than in-line environmental measures; this could be interpreted as a willingness to comply with regulations without changing fundamental attitudes. The above paper shows that Singapore is very strong at enforcing regulation (with 26,000 inspections carried out in 2003) but that managers believe that corporate, rather than government, stakeholders have the strongest influence on environmental measures while the local community have the weakest.

The main drivers in Singapore were considered to be corporate image, licence to operate and cost savings (often related to fines). In common with studies in Europe, however, managers in both Singapore and Malaysia feel that the cost burden of environmental measures cannot be passed on to customers and that public awareness of environmental issues are low. Newly introduced certification aims to increase awareness of manufacturing standards and generate a social attitude towards sustainability.

Supporting information – Green Label Certification

The Singapore government have introduced a new framework to teach manufacturers how to improve supply chain sustainability. The SMa, SEC and SPRING have collaborated to launch the industry's first sustainable manufacturing label. By providing a framework for manufacturers to establish a baseline on their current sustainable operations, the programme aims to boost the industry's green standards.

Yeo A, 'SG Sets Green Manufacturing Standard', www.procurement-online.com/news/16132, 4 Nov 2009

5.2.2 Malaysian sustainability drivers

Unlike Singapore, Malaysia's natural resources (e.g. palm and crude oil, wood and metals) have given its perception of sustainability a greater focus on controlling the extraction of resources, rather than on demand reduction. Despite this difference, the drivers for change are largely similar to Singapore and have a strong international focus.

Pressures on Malaysian companies to adopt environmentally responsible practices are reported to be stronger from international markets than local ones. Consequently the highest levels of environmental policy implementation are found in large, often foreign, MNCs. Large/medium-sized companies are increasingly using environmental protection and pollution prevention instruments, particularly if they sell their products to industrialised countries. However, smaller local companies emphasise profit maximisation and fear the cost of environmental initiatives. Lacking financial and human resource, as well as knowledge and environmental expertise, they are often unable to identify and realise the cost benefits of

efficiency gains and consequently have the lowest level of implementation. There is a perception amongst Malaysian managers that the enforcement of environmental laws is ineffective. As such, regulation has small influence on the implementation of environmental measures and local companies are not deterred by the threat of penalties (as they doubt the ability of regulatory bodies to enforce them).[79] In contrast, MNCs normally adopt global regulation as the basis for company standards; the Greening the Supply Chain programme (see example below) is an example of regional collaboration for industry-wide best practice towards sustainable goals.

Supporting information – Greening the Supply Chain

The Greening the Supply Chain (GSC) project aims to reach out to SME suppliers in Indonesia, Malaysia, Vietnam, India, Philippines and Thailand, to improve environmental practices and highlight energy conservation opportunities. The project creates environmental outreach programs with suppliers through collaboration with US and Asian companies who champion the values of GSC.

The project began in 1994 and currently works with 3,000 suppliers to provide technical support for increased energy and water conservation; it is funded by US private and public investment. Extensive use is made of the ISO 14001 and various supplier environmental management activity protocols. The project leads to benefits such as increases in efficiency, improved product quality and public image and innovation, leading to competitive advantages. Cost savings from improved efficiency generally average 5% - 10% and there are further benefits to surrounding communities including improved environmental protection, resource efficiency and water and energy conservation.

'Greening the Supply Chain' www.pi.energy.gov/documents/EWSL_gsc.pdf

The international focus of environmental management is also moving from local operational improvements towards optimisation of entire supply chains (e.g. production, consumption, service and product disposal). Here the emphasis is net maximum value creation across the supply chain with minimum environmental impact[80]. Several of the MNCs visited were actively seeking to improve the efficiency of their supply chains, predominantly for economic benefit. The disadvantages of this approach are likely to be greatest for smaller 'local' companies who may be forced to adopt sub-optimal performance at a local level.

As well as product properties, companies can also use cleaner *process* technologies to reduce or eliminate by-products and waste; this can result in reduced costs and often new markets or business opportunities. Organisations in both countries are looking at global best practice for their industry; for example, the Malaysian Palm Oil Board (MPOB) has recently been researching how to use plant waste after oil has been extracted. The MPOB's research is particularly important as it operates at a national level to enhance the efficiency of the entire industry.

Examples of government interventions include the EQA in Malaysia which prescribes both minimum percentages of recycled substances for specified products and 'eco-labelling' (declarations on recycled constituents and methods of manufacture and disposal)[81]. Malaysian customers are also following international trends in becoming increasingly aware of product contents and 'sustainability' issues. In some cases, a niche strategic marketing advantage can be gained (in international or domestic markets) by a sustainable product proposition; this was witnessed at YTL which marketed low-carbon products.

Case Study: MPOB

The MPOB is a government agency within the auspices of the Ministry of Plantation Industries and Commodities. The palm oil industry has faced some global criticism for perceived environmental impact through deforestation and destruction of natural habitats.

MPOB therefore funds research into the use of waste streams in palm oil processing, the production of plywood from fibrous biomass and the burning of methane from refining for energy production.

The MPOB's Technology Transfer week is used to inform plantation owners of the newest technologies and industry best practices. MBOP has developed 470 new technologies and 30% of these are actively adopted in the industry.

Case Study: YTL

YTL Corporation is one of the largest listed companies in Malaysia and employs over 6,200 people. Its seven core competencies range from Utilities and Cement to Hotels and Real Estate.

Currently YTL is one of the few cement manufacturers to use slag to complement clinker used in production. This reduces the process' CO_2 emissions and energy consumption by approximately half. This has allowed YTL to release *Greenlabel* products (a Singaporean rating, as yet not certified in Malaysia) to gain a unique marketing advantage.

While the company lists 'improving company image' as a key reason for eco-products, they say it is internally driven as one of the directors is the company's green champion driving the changes.

Case Study: NUS

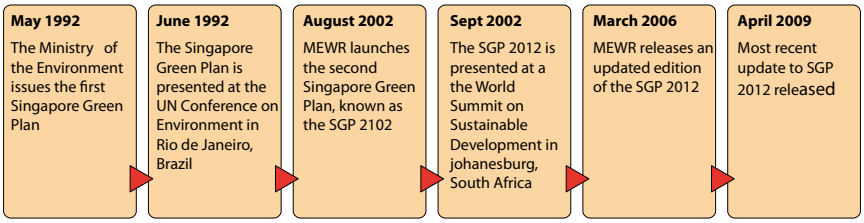
Key research areas at NUS currently include future transportation systems and smart sustainable cities. The former covers a number of different technologies including hybrid/electric cars and energy storage technology. The latter is a joint venture with architecture focusing on providing Asia-centric solutions to urban development; it is hoped that it can then be exported to other countries facing similar issues. Research topics include management of water resources, air pollution, infrastructure, transportation and sustainable energies.

Undergraduates are also encouraged to participate in sustainable projects. At the time of visiting, a group of undergraduates were preparing for the Shell Eco-Marathon (Asia) to be held at the beginning of July 2010.

5.3 How does sustainability feature in government policy?

5.3.1 Singaporean government policy

In recent years, both Singapore and Malaysia have made considerable advances in industrialisation whilst creating plans for long-term green policy. In Singapore, there exist a number of policies concerning sustainability but the most relevant is the Singapore Green Plan (SGP), Singapore's environmental blueprint for the future. Its objective is to ensure that Singapore, via sound environmental management, achieves economic development that *"meets the needs of the present generation without compromising the needs of future generations*[v]*."* The first Green Plan was released in 1992[82] by the Ministry of the Environment and Water Resources (MEWR). The timeline for SGP is summarised in the figure below:



The SGP is now divided into a number of 'focus areas'; Air and Climate Change, Water, Waste Management, Public Health, International Environmental Relations, Innovation and Community Partnership.[83] In addition to the SGP, the Singaporean Budget (April 2009 to May 2010)[84] also contains numerous mentions of green initiatives to support strategically valuable technologies[85], for example:

- The enhancement of Transport Technology Innovation Development Scheme for new green vehicles
- Commitment of S$450 million over five years to start a Public-Private Co-Innovation Partnership to develop innovative solutions in areas including environmental sustainability and energy security

In the 2009 Budget[86] it was declared that S$1bn would be spent over the coming 5 years on sustainable development initiatives. These funds will support programmes such as energy efficiency for industry and households, green transport, clean energy and the greening of living spaces.

The Singaporean government also believes that the signing of the Accord Agreement[87] at The United Nations Climate Change Conference (UNCCC) in Copenhagen (December 2009) should help Singapore to reach legally binding agreements on climate change. Combined with this, MEWR have confirmed that targets on greenhouse emissions and energy use would remain key performance indicators to compare current practice against the Singapore Green Plan.

As well as government initiatives, numerous NGOs have become involved in publicising environmental challenges and recommendations. An important contributor is the Singapore Environmental Council (SEC) which promotes "*environmental awareness and action*"[88]. Although Singapore is considered to have effective legal environmental controls, the legislation involved is spread over at least two dozen acts and falls under several government bodies. The reasons for the success of law enforcement, however, are given as a comprehensive planning process (involving all relevant government bodies) and Singapore's small size.[89]

[v] As discussed earlier, this is the definition of sustainable development from the 1987 UN Bruntland Report.

5.3.2 Malaysian government policy:

Malaysian government polices are driven by its long-term goal of development embodied in Vision 2020 (see box below); environmental themes are not a central feature of this policy as it was created in 1991 when the global environmental agenda was not well developed. Within the more recent National Mission, however, the government places emphasis on development over environmental sustainability, with the latter falling mainly within the Fourth Thrust (see 'Supporting information' below). Government priorities include the '*efficient usage of resources*' and '*ensuring the sustainability of energy supply and environmental sustainability and resource management*'.

Supporting information – Vision 2020 and the National Mission

Whilst Malaysian policy is conducted in five year cycles or 'Plans', it is also driven by a long-term policy of economic development, launched in 1991, called Vision 2020 (Wawasan 2020 in Malay). It details 'nine central strategic challenges' that need to be overcome in order that a self-sufficient industrial, Malaysian-centric economy can be achieved by 2020. This vision became a national goal, and was even embodied in a patriotic song. In order to support the required advances a "National Mission" was created in 2006. This Mission is supported by 5 "Thrusts".

The 5 Thrusts of the National Mission

- To move the economy up the value chain
- To raise the country's capacity for knowledge, creativity and innovation and nurture first class mentality
- To address persistent socio-economic inequalities constructively and productively
- To improve the standard and sustainability of our quality of life
- To strengthen the institutional and implementation capacity of the country

Warhoe, S.P. "Malaysia, A Country Looking Ahead with Vision 2020", Cost Engineering, 39(9), 1997, p16

Case Study: Guinness Anchor

Guinness Anchor Berhad (GAB) is the market leader in beer and stout production in Malaysia; the company is part owned by Diageo and Asia Pacific Breweries (APB).

GAB is conscious of efficient usage of resources in many ways. An 85-95% bottle return rate for refilling ensures minimal numbers of new bottles are required.

Water quality is also closely monitored due to strict effluent controls along with the adoption of various water conservation policies. GAB has several schemes to educate primary school children about water conservation to counter the local culture of seeing water as an infinite resource.

Similarly, GAB reduces the amount of energy they use by efficient process design; e.g. the beer is only cooled once and allowed to head up naturally throughout the process.

GAB is attempting to stay ahead of changes in Malaysian legislation in order to avoid step changes in production processes.

Rapid development has led to growing environmental problems; high growth rates have drawn heavily on the natural resource base of Malaysia, both renewable and non-renewable. The government has begun to take a preventive approach rather than previous curative measures. For example the 1974 Environmental Quality Act (EQA) prescribes licences for the occupation of premises (containing conditions for both pollution control and use of the premise); the Act remains, but more recently the National Policy on Environment provides a framework for the integration of environmental considerations into development planning.[90]

Malaysian governance is often characterised by strict and well-enforced legislative and interventionist measures; however, the enforcement of environmental laws remains a challenge[91] as responsibility is divided between the Department of the Environment and 15 national states.

The 2009 National Budget identified 'green technology' as an important component of Malaysia's future economy[92] and gave strategies to support and encourage the establishment of green industries in the National Green Technology Policy (NGTP)[93]. It encompasses elements of energy, economic, environmental and social policies and sets out short, medium and long-term goals.

Case Study: SIWW

Singapore International Water Week 2010 was a week-long exhibition on current and future initiatives to provide a sustainable water supply for the country. Initiatives included the following.

Hyflux-SingSpring Desalination Plant was the largest desalination plant in the world when opened in 2005. Desalination currently accounts for ~10% of Singapore's water sourcing but is set to rise to ~30% with the building of a new plant announced at SIWW 2010. Drawbacks include high costs due to energy prices but the government guarantees prices to ensure supply.

Sembcorp's 5th NEWater plant is among the largest plants in the world with a daily capacity of 218,000m^3. Recycled effluent currently accounts for 30% of Singapore's supply but is set to rise to 50%.

Finally, 67% of rainwater is currently collected and sent to reservoirs. Future investments are set to raise this to 90%.

All of the above measures are intended to allow Singapore to become self-sufficient in water supply. This will eliminate the need for Malaysian water imports which currently account for 50% of supply.

Aligned with this policy the budget included other initiatives such as:

- The development of a National Green Technology Centre
- A fund offering soft loans to companies that supply or utilise green technologies
- A Green Building Index, offering tax exemptions to owners and buyers

Supporting information – fragmentation of agencies

"Green technology efforts have always been fragmented with different ministries and agencies running their own projects. Environmental initiatives often involve several parties across the government, so we need to first strengthen the institution. The [Green Technology] council will take a consolidated approach, providing a national strategic focus and plan".

Senior Undersecretary Haji Abdullah, Head of the Green Technology Division which was set up at the same time as the launch of the Green Technology Policy.

The 2010 National Budget[92] continues to support the goals of the NGTP and progresses it further by bringing together institutional stakeholders with the foundation of the Green Technology Council. It appears that sustainability is moving up the government agenda and NGOs also play an important role in the country's sustainable development efforts. In a country focused on its development, however, environmental NGOs are generally perceived to have "anti-development" positions.[94] Often unsuccessful in pursuing legal complaints, most NGOs pursue strategies of applying political pressure by raising public awareness.

5.4 How are resources managed in the region?

In both countries, green industries are considered to be strategic investments and an opportunity for future wealth generation. In Singapore, the emerging global green-tech industry is viewed as an opportunity to consolidate its position as a producer of high-tech and high value-adding goods. In contrast, in Malaysia green technology is seen as an opportunity to progress up the value chain.

Both nations have issues to address regarding the sustainable management of their own resources, however. In Singapore, the lack of natural resources drives efficiency and emphasis on resource management. For Malaysia, the economic opportunities presented by the exploitation of natural resources can result in requirements conflicting with environmental concerns.

5.4.1 Singapore's resource management

Water supply

Singapore is concerned about its dependence on Malaysian water imports; ongoing political tensions between the countries are driving Singapore to seek self-sufficiency. Singapore therefore aims to reduce its dependency on water imports through a combination of demand and supply management; political will, financial resources and the ability to steer R&D investment has led to considerable recent progress. As an example of supply management 100% of waste water is collected and treated using world-leading dual membrane and ultraviolet technologies. Demand management involves metering and tiered water rates; the price increasing as usage increases. Given the value and importance of water in Singapore, the government is careful to ensure that a suitable calibre

of employee is attracted to public utility companies through competitive remuneration packages. This, combined with suitable measures in place to deal with corruption, mean that water accountability is high throughout the supply chain (unlike other Asian nations where up to 60% of water is unaccounted for in cities).[95]

Recycling and end-of-life management

A recent paper comparing municipal waste management in Singapore and Berlin reveals an interesting point about Singapore's recycling[96], which is that it is mostly commercial rather than domestic waste that is recycled. Reasons for this are given as: the inconvenience of recycling in high-rise buildings with centralised waste facilities, the perception among Singaporeans that they do not have time to recycle, and lack of public knowledge about what can and cannot be recycled.

End-of-life management is becoming increasingly important in industry and the servitisation of manufacturing has led to a greater focus on product disposal and sustainability issues. Rolls-Royce has chosen to provide "power by the hour" and thus has greater responsibility for the integrity of their engines, both in service and at end-of-life. Singapore Aero Engine Services Limited (SAESL) plays a critical role in this assessment, especially important in the aerospace industry given the value of the materials used in such products.

Biodiesel

Singapore is investing in second-generation biofuels, produced from inedible feedstock, in response to increasing demand from other Asian countries. The technology is not yet ready for industrialisation, but with further development it may address the problem of food crops being used for fuel. Singapore's current biofuels are often produced from Malaysian palm oil (see below) and Neste Oil of Finland is planning to produce 800,000 tonnes of biodiesel per year from Malaysian palm oil in a new Singapore refinery from 2010.[97]

Energy utilisation

Singapore is currently dependant on imports of oil from the Middle East and natural gas from its neighbours. Rising oil prices have been cited as a reason for increased interest by the general public in energy policy. The government claims that Singapore is unsuitable for renewable energy sources such as wind and hydro-electric generation due to its size and geography, although work is being carried out to incorporate 'clean energy' into transport systems and buildings, predominantly through solar technology.[98] Energy strategy includes a commitment to diversification of energy sources in order to reduce reliance on imported oil and gas. An example of this is the construction of a Liquid Natural Gas (LNG) terminal, due for completion in 2013. Further initiatives include promoting energy efficiency among businesses and the public, and the decision not to subsidise energy so that cost will drive reduced consumption.

Supporting information – smart meters

Trials of smart meters in Singapore in 2007 yielded a 2% reduction in electricity consumption and a 10% reduction in peak time energy consumption. The latest trial will involve thousands of smart meters with the eventual aim of implementing an energy vending scheme where customers can pay upfront for electricity and choose their supplier on a purchase-by-purchase basis.

'Singapore to trial EVS with 1000 users from Nov. 2008' http://tinyurl.com/35wusme

5.4.2 Malaysia's resource management

Sustainable forestry

The timber trade is important to the Malaysian economy; exports of timber in 2006 were worth 3.4% of GDP.[99] The principle of sustainable forest management has been imposed on Malaysia by international markets but the cost of sustainable forest management is high; RM1.7 billion in Peninsular Malaysia alone. The cost is to be met through levies imposed on forestry products[100] and current, market-driven certification is serving as a tool to promote sustainable forest management[101].

The government is keen to develop both secondary and tertiary wood processing industries with the aim of increasing the efficiency of utilisation. To this end, the export of raw sawlogs has been banned in some areas and restricted in others. However, it has been argued that log export restrictions have been economically inefficient and have exacerbated environmental degradation by encouraging wasteful resource use[100].

Malaysia is committed to maintaining 50% of its land under forest cover. Currently the natural forest base (excluding agricultural tree crops) is 57%, of which 75% is designated Permanent Forest Estate where commercial logging is regulated.

Palm oil

Malaysia is the world's largest exporter of palm oil and dominates the trade with a 45% market share[102]. The industry directly provides over 800,000 jobs. A highly versatile product, palm oil is a raw material in the production of food products, personal care products and fuels.

Malaysia considers the palm oil industry to be crucial to the elimination of rural poverty[103]. Following race riots in 1969 the government introduced policies of land redistribution, including schemes giving smallholdings of palm trees to the 'landless poor'. This scheme *'marked the beginning of the key role played by palm oil in the export diversification and poverty alleviation programs of Malaysia'*[104]. Due to the strategic significance of the industry, representatives are sometimes sensitive to criticism of environmental management and can object to 'misinformation' on the environmental impact of palm oil; e.g. highlighting 'unfair calculations'[105]

Supporting information – Sime Darby

In 2006, the Malaysian government initiated the merger of several firms to create the world's largest listed oil palm plantation player in a landmark deal valued at RM31 billion. Synergy Drive acquired eight listed companies, creating the world's largest plantation company, Sime Darby. This new entity could produce 2.5 million tonnes of palm oil or 5% of global production in 2006. Researching various possibilities for breakthrough in biotechnology related to palm oil, it is committed to constant innovation to expand the usage of palm oil and reduce plantation wastes.

The company is also involved in plantation downstream activities such as oils and fats and oleo chemical business. Sime Darby's plantations interest in Malaysia is represented by a total of 140 oil palm estates spanning over 329,470 hectares in Peninsular Malaysia, Sarawak and Sabah. The company has 42 oil palm mills throughout Malaysia, average capacity of 49,870 tonnes a day. Sime Darby plantations implemented Zero Burning Planting Techniques (ZBPT), a practical and environmentally sound technique of replanting, in 1989: the old and uneconomical stands of oil palms are felled and shredded and left to decompose.

Thomas, S.E. "Sime Darby Berhad: The Birth of a New Malaysian Global Champion"

of carbon emissions. The Malaysian industry sometimes seeks to distance itself from the practices of other nations (notably Indonesia) which damage the reputation of the entire global industry.

The large amounts of organic waste and emissions resulting from the deforestation of rainforests to create plantations raise sustainability issues. Every tonne of palm oil produced generates 12.5 tonnes of waste. Opportunities have been identified, however, to turn this waste into products such as renewable electricity and bio-plastics.

A variety of organisations have been formed to address these issues at an industry level receiving governmental support and funding. Examples include the Palm Oil Research Institution whose remit is to develop measures to *'reduce emissions at reasonable cost'* and improve enforcement mechanisms. Palm oil mill improvements are eligible for funding via registration with the Clean Development Mechanism of the Kyoto protocol; eligible projects include composting, biogas capture and biomass to energy production. Some are sceptical that such innovations will definitively solve the industry's key issues given the reported levels of 'corruption' surrounding elements of the palm oil supply chain between plantation and refinery[106].

Biodiesel

One of the main uses of palm oil (which accounts for much of increasing demand) is its inclusion in many bio-diesels. It is argued that organic compounds derived from palm oil plants do not add to overall carbon dioxide levels when burned in engines as it is balanced by the CO_2 absorbed by the plant in its life. Its use in biodiesel has proved controversial, however, as the expansion of production has required the draining and burning of peat-land for plantation and it is argued that the resultant release of CO_2 (and habitat loss of endangered species) outweighs the CO_2 benefit of the biofuel.[107]

The biofuel industry itself is expanding in the region due to a number of factors influenced by both international and local government legislation. For example, the EU is bound by its 20-20-20 legislation to have 10% of transport fuel from renewable sources, including biofuels.[108] Palm Oil is an attractive source for bio-diesel as production capacity can fulfil both food and fuel demands[109]. In 2007 Malaysia opened its first biodiesel plant in Pahang, with a 100,000 tonnes annual capacity.

Energy

Malaysia has a limited supply of non-renewable energy sources and relies heavily on coal and gas for electricity generation; at current production rates, oil reserves will also be exhausted in about 20 years[110]. Energy policy focuses on diversification of fuel sources, demand management and encouraging co-generation. Malaysia has therefore adopted a Five Fuel Policy for its energy supply, which includes oil, natural gas, coal, hydroelectricity and renewables.[111] A proposed Feed-In Tariff also forms part of the 10th Energy Plan[112]; the tariff includes all renewables and will differentiate between technologies accounting for the cost of generation. It is estimated that this programme will add 2% to the average electricity bill in the country.

There have been several incentives implemented to encourage the adoption of renewables, in particular solar PV; these include the introduction of feed-in-tariffs and import tax exemption. Year-round

Case Study: Recycle Energy

Recycle Energy operate and develop the technology used in the only integrated solids waste management (ISWM) plant in Malaysia.

Organic waste is separated from recyclable waste, the former being converted to Refuse Derived Fuel (RDF) which is burned in the WtE plant, and generates a significant revenue stream for the company.

sunshine makes solar panels an attractive option and Malaysia is looking to exploit solar PVs to use them on a large scale as well as on domestic buildings. Subsidies for fuel have been a feature of Malaysian policy, however in 2008 they were deemed unaffordable and were cut.

Case Study: REC

The Renewable Energy Corporation (REC) is a world-leading, vertically-integrated company in the solar photovoltaic industry. As of 2008, the group employed approximately 2500 staff, of which 1400 were located in Singapore.

The group has just constructed the world's largest integrated solar energy production facility in Singapore. The factory will eventually have the capacity to produce approximately 0.6GW of solar panels per annum. The construction project obtained the Singapore Building and Construction Authority 'Green Mark', indicating that the buildings meet criteria for energy efficiency, water efficiency, project management, good indoor environmental quality and environmental protection.

Despite the relatively high labour cost, Singapore was ultimately chosen because of its developed infrastructure, stable political situation, legal transparency, skilled workforce, government incentives, and provision of land (including free reservation of land for future expansion).

The products produced by REC are designed specifically to have a low energy content, so that the energy payback period (energy generated from the solar panel equals the energy used to make it) is only one year, with the guaranteed life of the product at 25 years.

5.5 What other key green industries are being developed in the region?

5.5.1 Solar panels – Singapore and Malaysia

As well as improving resource usage, both countries have developed some other green industries. Singapore and Malaysia have attracted investment in solar panel manufacturing, and their governments are keen to encourage more. A notable example is Norway's Renewable Energy Corporation, which has chosen Singapore as their site to build a 550MW capacity manufacturing complex. Similarly, Malaysia successfully attracted the US-based First Solar to build a 200-megawatt capacity solar-module manufacturing plant in Kulim.

Malaysia has deliberately targeted solar as a strategic opportunity to corner a high-value market, building on capabilities developed in the manufacture of silicon-based computing components. It is an attractive location for manufacturers, offering good infrastructure and relatively low-cost labour force; the government is also supporting the development of local research centres in universities. Both countries are located close to large potential markets although currently the majority of exports are to the EU.

5.5.2 Electric vehicle trials – Singapore

Singapore is an ideal location to start an electric vehicle programme because distances are relatively short and the population density is high. The government is investing S$20 million to trial electric vehicles from 2010 and memoranda of understanding have been signed between Renault-Nissan and Keppel Energy; the former will supply the electric vehicles and the latter will develop charging stations and other necessary infrastructure. The test bed will serve as a place for other companies to trial solutions intended for both Singapore and other markets.

5.6 Green conclusions

Literature research indicates that sustainability issues in Singapore and Malaysia are different to those experienced elsewhere. The principal reason for this is that some concerns are only relevant to the two countries. Singapore is a city-state and has constraints on space and a dependence on imports of energy and water from its neighbours. Singapore also benefits from a government with a high level of control, easing policy implementation. The challenge for Singapore is therefore to conserve the resources within the island's boundary and to make the city as self-sufficient as possible. Indeed, there has been some controversy over the increase in this boundary over the last decade due to an active land reclamation policy. Singapore has also attracted considerable investment in renewable energy, in particular the solar and wind industries.

Malaysia, by contrast, is a developing country and some of its progress is based on the exploitation of its abundant natural resources such as rubber and palm oil. At a national and regional level, the country is striving to lower its dependence on trading these resources. The government has, like Singapore, identified the green technology industry as an area of opportunity and has successfully attracted a number of solar PV manufacturers to the region.

Both countries rely on export for their GDP and as a result partake in international supply chains which are both highly regulated and subject to scrutiny from the global sustainability agenda. MNCs locating in the region normally conform to standards (e.g. ISO 1400X) which are more stringent than the local regulations in terms of, for example, pollutants and control of hazardous feedstock materials. Additional pressures include those from western consumers, however their awareness and concern over sustainable sourcing and manufacturing tends to be restricted to primary and secondary products (e.g. wood and palm oil, furniture or biodiesel). Issues of sustainability concerning tertiary products (e.g. computers and appliances) are less prevalent in the minds of many consumers; this may suggest that Malaysia is under more pressure to adopt sustainable practice than Singapore, which produces few commodity materials.

From a green technology perspective, the scale of activity in the renewable energy sector market became clear from the case interviews, both in Singapore and Malaysia. The Renewable Energy Corporation (REC), taking advantage of favourable corporate taxation and the availability of skilled workers from the semiconductor industry, has developed the world's largest integrated[vi] fabrication plant for crystalline solar modules. In Malaysia, First Solar, the world's leading company in Thin Film photovoltaics, have chosen Malaysia as their primary production site and are continuing to expand their plant in Kulim.

Recycling and remanufacturing were also recurring themes, especially in Singapore. Institutional bodies, for example SIMTech, are involved with a number of MNCs to reduce landfill waste by either remanufacturing used parts or identifying alternate end-of-life strategies for these goods. However, such R&D progress appears somewhat slower in other areas as many challenges remain unsolved in certain industries. Crucially, the palm oil industry continues to have high levels of organic pollutants in waste water and the process itself has witnessed limited development in recent years; initiatives by government sponsored bodies such as the MPOB are, however, actively working with partners to help development in this area.

[vi] i.e. vertically integrated from the processing of silica to the production of assembly solar modules

6 Overall conclusions

Some common themes emerge from the three research topics that have been investigated. The first theme is the desire of both Singapore and Malaysia to reach and maintain high positions in the value chain; the difference between the countries being their current positions. Singapore is already developed, is one of the world's top innovators, and has a high GDP per capita (a large percentage of which comes from high-value manufacturing). The aim for Singapore is therefore to maintain high levels of foreign investment by targeting emerging industries such as clean technology, life sciences and digital media. This strategy will thereby enable Singapore to maintain its position as a world-leading exporter of high-value goods. Malaysia, however, is currently less developed and has traditionally produced lower-value primary goods. Historically it has benefited from a high level of foreign investment by Japanese, American and European MNCs which viewed the nation as an ideal, low-cost manufacturing region in the late 1960s and early 1970s. The aim of the Malaysian government is now to develop the economy, both by moving into higher-value sectors (using initiatives such as technology clustering) and by exploiting existing skills to develop green technologies. The aim is that R&D capabilities and knowledge will replace low-cost labour as the country's competitive advantage. To an extent, government incentives appear to be moving Malaysia in this direction, however in certain sectors a shortage of suitably qualified science and engineering graduates is perceived as a barrier to achieving this aim.

The research also highlighted the different ways in which the Singaporean and Malaysian governments are attempting to reach this shared goal. Singapore has a high degree of governmental control and intervention. A trade-dependent country, its government is focused on sustaining Singapore's position as a good place to do business and a high-capability economy. Maintenance of an attractive tax system, a transparent legal system, high-quality education, and an efficient logistical network are all government policies to achieve this objective.

Malaysia aims to become a 'self-sufficient, industrial, Malaysian-centric economy' in order to reach developed country status by 2020. National and regional governments provide support for SMEs and local industries, and continue to attract investment from high-tech, foreign-owned MNCs, both to grow the local economy and to facilitate knowledge transfer. They also take a more protectionist stance than Singapore, with foreign participation in many sectors restricted and a high level of bureaucracy (sometimes with alleged corruption). The exact relationship between Malaysia's national and regional governments was not explored in this study; it did, however, appear that regional governments were often equally or more successful than national government at attracting investment. From the case interviews we conducted, the influence and reach of the regional governments in the Malaysian states also appeared to vary considerably.

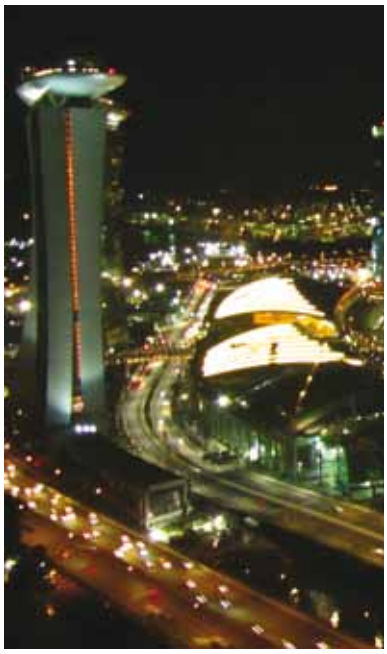
Comparing the two countries directly, two recurring labour themes were apparent. The first was highlighted by the responses of the various MNCs visited, in particular in the semiconductor, aerospace and renewable energy sectors. Singaporean industry works closely with academia (via government-mediated committees) to tailor education courses to fit the needs of companies locating and investing in the country. This mechanism was not as effective in Malaysia. Conversations with institutional players in Malaysia confirmed that suitable lines of communication between

industry and academia were limited; there are therefore some skill mismatches between the abilities of graduates and the requirements of hiring MNCs. By contrast, more traditional industries, such as shipbuilding, newspaper printing, palm oil processing etc, faced similar challenges in both Singapore and Malaysia. Whilst there is no shortage of manual labour (predominantly from neighbouring SE Asian countries) there was some difficulty in attracting and retaining qualified graduates to senior technical and managerial positions. This is, perhaps, a consequence of the drive by both nations to move up the value chain. However Malaysia, in particular, faces a difficult balancing act to maintain national revenue from traditional sources whilst encouraging development in new emerging industries.

Malaysia faces another challenge which Singapore, perhaps due to its smaller size or tighter governmental control, does not appear to have. Some of the companies visited in Malaysia appeared unaware of the activities of others in their own, or related sectors. With the possible exception of KHTP, Malaysian enterprise did not appear as well placed to leverage benefits from clusters and networks that were evident in a number of cases in Singapore. Overcoming this barrier to information exchange may be another key element in the successful future development of Malaysia as a nation.

Various challenges were faced by both countries relating to sustainability issues. Both governments have seen potential opportunities arising as a result of the global environmental agenda and are trying to benefit their economies accordingly. To date, Singapore and Malaysian have both attracted significant investment in the solar industry, building on the skill sets developed historically in other industries. It was also evident that the operations of most MNCs operating in either country were defined by global ISO standards and the companies' own internal standards.

One of the key differences in approach to sustainability between the two countries, however, was due to Singapore's very limited natural resources. Water, energy and material conservation therefore feature highly in Singapore's national interests and their government is steering and supporting investment accordingly. In contrast, Malaysia has considerably more resources and is more focused on using revenue from traditional, resource-based industries to aid national economic growth towards a knowledge-based economy. Research in such traditional industries has, in the past, been relatively slow although organisations such as the Malaysian Palm Oil Board are slowly improving development in the palm oil industry.



To conclude, two weeks of industrial visits allowed insight into many issues; given more time and resources, however, future research could include a number of topics. Eastern Malaysia contains a different industrial mix to the Peninsular which could provide interesting new insights. The relationship between national and regional governments in Malaysia could also be explored in more detail along with further analysis of Singaporean investment incentives.

What can be said with confidence, however, is that Singapore and Malaysia sit in an excellent strategic geographical location and claim to be *the* cultural bridge between East and West. Whilst their industrial success to date has been relatively poorly documented compared to the BRICs, industry and academia alike would be well advised to follow both countries' future development as they carve unique positions in global manufacturing industry.

Glossary

A*STAR: Agency for Science, Technology and Research
BRICs: Brazil, Russia, India and China
EDB: Economic Development Board
EQA: Environmental Quality Act
FDI: Foreign Direct Investment
FMM: Federation of Malaysian Manufacturers
FTZ: Free Trade Zone
GAB: Guinness Anchor Berhad
GDP: Gross Domestic Product
GIP: Global Investor Programme
GSK: GlaxoSmithKline
ICT: Information and Communication Technologies
IfM: Institute for Manufacturing
ILP: Industry Link Programme
JTC: Jurong Town Corporation
JV: Joint Venture
KHTP: Kulim High Technology Park
LNG: Liquid Natural Gas
LTVP: Long-Term Visit Pass
MEWR: Ministry for Environment and Water Resource
MIDA: Malaysian Industrial Development Authority
MNC: Multi-National Corporation
MOSTI: Ministry of Science, Technology and Innovation
MPOB: Malaysian Palm Oil Board
MSC: Multimedia Super Corridor
MTDC: Malaysian Technology Development Corporation
MTI: Ministry of Trade and Industry
NGO: Non-governmental organisation
NGTP: National Green Technology Policy
NTU: Nanyang Technical University
NUS: National University of Singapore
PRI: Public Research Institutions
PwC: PricewaterhouseCoopers
R&D: Research and Development
SEC: Singapore Environmental Council
SEEDS: Start-up Enterprise Development Scheme
SGP: Singapore Green Plan
SIMTech: Singapore Institute of Manufacturing Technology
SME: Small and Medium Enterprise
SMIDEC: Small and Medium Industries Development Corporation
SPRING: Standards, Productivity and Innovation Board
UNCCC: United Nations Climate Change Conference
VC: Venture Capital
ZBPT: Zero Burning Planting Techniques

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MET

The Manufacturing Engineering Tripos (MET) is a unique two-year programme comprising the 3rd and 4th year of the Cambridge engineering degree. Students study the full range of manufacturing and management issues including marketing, design, materials, manufacturing systems and human resources – all within a financial and business context. A rigorous theoretical basis is combined with the opportunity to put ideas into practice in industry.

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The culmination of the MET course is the overseas research project and tour, which is organised by the students. Previous tours have included 'Unpicking the fabric of Brazil's industrial development...' (2008) and 'Hot-Stuff... India's recipe for industrial success' (2009).

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The Institute for Manufacturing (IfM), is a division of the University of Cambridge's Department of Engineering. The IfM brings together expertise in management, economics and technology to address the full spectrum of industrial issues. Its activities integrate research and education with practical application in companies, providing a unique environment for the creation of new ideas and approaches to modern industrial practice. The IfM works closely with industry, at a regional, national and international level, providing strategic, technical and operational expertise to help companies to grow and to become more competitive.

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