

Is the grass really greener?

Investigating the industrial eco strategies of South Korea

Report of the MET Overseas Research Project 2012



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Industrial Foreword

At Innocent a simple and well-defined purpose, some deeply-held shared values and a clear unifying vision have provided a fundamental basis for our success. The METII students of 2012 have found that the galvanising clear purpose of resurrecting the Korean economy after WWII has underpinned the astonishing development of the Korean Chaebols into the engines of the emerging global manufacturing power that is today's South Korea.

S. Korea's economy is unquestionably resurrected, and as such the simple clear purpose is no longer so compelling. The relatively straightforward strategies deployed by government and business in the 20th Century are no longer sufficient as S. Korean companies seek to take global leadership (rather than fast follower) positions in key sectors, and to compete through innovation.

Increasingly, sustainability (or business longevity) for global businesses is about managing the "Triple Bottom Line"¹ i.e. maintaining a positive balance in each of the financial, environmental and social ledgers: ultimately failure in any one of the three aspects means failure to survive. The contraction of the UK manufacturing sector in the 20th Century is readily attributable to financial failure, although deeper analysis may also indicate social causes. How will S. Korean businesses fare in each of the Triple Bottom Line aspects as they seek to fulfil their global leadership potential? And what lessons can we bring back for the companies that remain in the UK?

Steve Spall

Operations Director

Innocent Drinks



¹ John Elkington, 1997, Cannibals with Forks: the Triple Bottom Line of 21st Century Business

Academic Foreword

It is exactly 25 years since the first MET team set off for Korea. At that time it was something of a step into the industrial unknown. The now great names – Samsung, LG, Hyundai & POSCO – were barely known outside Korea. But even then there was evidence of something rather special going on. We found a fiercely hard-working, purposeful and ambitious people with a zest for living and a great sense of humour!

Traditional economists had advised against their strategies of focusing and developing key industries. They picked the wrong country! Indeed many who accepted the then conventional advice have fared far less well than Korea with its independent approach and focus.

The results of this waywardness are now plain to see – a sophisticated industrial economy that has dramatically improved the lot of its people and is competing head to head with world leaders in key sectors. Its rates of research investment and innovation overshadow the so-called developed economies. It has levels of academic achievement others can only dream of.

Perhaps we should not be surprised. This is an ancient nation whose ruler centuries ago sought to make knowledge accessible to all through a new alphabet. A nation which has traditionally encouraged education. A nation with a proud culture.

The 2012 MET team was privileged to be given access to a wide range of world-class companies and people. They saw at first-hand what intelligence, drive and hard work can achieve. These are good lessons at personal, institutional and national levels.

My warmest thanks go to the many Korean hosts who gave of their time and wisdom to inspire our young engineers.

Professor Sir Mike Gregory
Head of the Institute for Manufacturing



MET Foreword

The history of the industrial revolution is the history of the political and economic outsiders in the North of England having to develop and produce things of value to other people to earn their place in the world. In the process they created the modern, technical, egalitarian world we know. Times change but it is still the outsiders who move things on. In two weeks in South Korea we have witnessed this continuing human cutting edge, driving hard, determined to make it work. Seriously well integrated and creative dockside steel-making, ship-building and car-making plants and all the associated heavy industry and very sophisticated component development and manufacturing plants make South Korea a globally leading zone in primary, secondary and tertiary industry. Wake up UK. This is a world waving you bye-bye!

Jim Platts

Lecturer

Institute for Manufacturing



Executive Summary

From the outside looking in, South Korea can be on first impressions a mysterious country, but behind the façade of what in times of antiquity was called the “Hermit Kingdom” lies one of the economic powerhouses of the present day. This report is the culmination of a year-long project by students from the University of Cambridge to uncover what has driven this country to become what it is today, and what will shape its future.

First we address the question of sustainability, undoubtedly one of the major themes in business today. At a nationwide level we will find major top-down environmental projects and plans to make Korea a more sustainable economy. At a business level we will find many companies who echo the sentiments that sustainability is very important to their businesses, but probe a little further and it becomes clear that economic sustainability will always come before environmental sustainability. The rise in the west of “eco-friendliness” is neither common in Korea nor helpful. If businesses sacrifice competitiveness for the planet, they may help the environment in the short term, but in the long term a competitor who made the opposite choice will often prevail, nullifying the efforts of the “greener” company. However for green projects which do provide a robust business case, Korea could teach the UK many things in terms of strong leadership and innovative thinking to combat the NIMBY (“Not In My Back Yard”) phenomenon so common in the West.

Secondly, we investigate exactly how Korea has positioned itself in the future manufacturing landscape. Currently, Korea has huge business interests in shipbuilding, automotive and consumer electronics. Many of these competencies stem from the need for Korea, as a mineral-poor nation, to import many raw materials from an early stage. Although since then the national capability for producing many materials (particularly steel) has flourished, the national resource supply question has now re-emerged not with metals and food, but with energy. Energy self-sufficiency is a huge theme in Korea currently, and renewable energy sources such as wind, solar and wave are seen as the key. Many large Korean companies are therefore moving to make Korea a world leader in wind energy, not just for the economic potential, but at a deeper level, as a matter of national security.

Finally, as Korea shifts from being simply a large scale manufacturer of foreign ideas, to having industry leading innovative companies, we must address the issue of innovation. Historically, Korea has been seen as a fast follower in many industries but this is beginning to change, and no-where is this clearer than in the smartphone war where the once omnipotent iPhone has now been outsold for the first time, by the Korean made Samsung Galaxy S3. This is visible within Korea where until now most companies have had large private R&D facilities, many of which are now starting to look

outwards to the rest of the world for ideas much more than in the past. This change in situation requires a change in approach and we have seen many firms realising that their current way of organising innovation will have to change. One of the most obvious signs of this shift in approach is the recent wave of American and European executives being brought in a board level into Korean companies to act as advisors, when traditionally Korean firms have been extremely racially homogenous.

In summary, the powerhouse of the Korean economy shows no signs of slowing, and there is a clear economic plan for where the country is heading in the future. What will be interesting to see is whether the structures and cultures of Korean companies can make the shift required to reposition themselves as more than just a mass manufacturer of goods, but as a centre of innovation and high value manufacture. This shift has already begun, and so far has been economically successful, however Korea has only begun to truly see the environmental impact of the economic boom which brought it to where it is today. As Korea continues to grow, especially in the areas of renewable energy, it will at some stage have to take responsibility for its environmental wake. In terms of what this means for the rest of the world, we should all take note: Korea is skilled, determined and most of all, has a plan. Korea is on the rise and the best is yet to come.

Alan Cruickshank

MET 2012 Project Co-ordinator



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1 Introduction

1.1 The Initial Questions

The 2006 Stern Report caused the world to sit-up and realise the urgency of tackling climate change. The report estimated that failure to act decisively within the next 10 years could cost the global economy up to £3.68 trillion, with governments expected to drive necessary change. Following on from this, the recent Rio+20 Earth Summit (2012) has highlighted a shifting need for individual companies, communities and organisations to take the lead rather than governments, with \$500m worth of non-globally negotiated commitments far outweighing the impact of the official document produced. To understand how manufacturers can thrive in this context three core themes were selected for this report:

Sustainability

What does it mean to be sustainable in the modern world? We consider how governments and businesses should respond to the environmental challenges to come. What will be the impact of climate change, and the predicted increase in frequency and severity of natural disasters, have on supply chains and businesses, both locally and internationally.

Manufacturing and its future

How should the UK and Korea position themselves for the future manufacturing landscape? A focused investigation has been undertaken into how sustainability can become a key part of the UK and Korea's future economic and manufacturing strategy on the world stage.

Innovation

Where do ideas come from today? What can be done to support innovation in the future? An analysis of how current innovation strategies are put into practice and how companies can ensure that the most promising ideas are brought to the attention of those with the capability to make them a reality has been compiled.

By investigating the approaches followed by Korea, we can gain a much greater understanding of the most effective green strategies for the future. With ever increasing interconnectivity between nations and a greater reliance on others for key resources and capabilities, the question of how to position ourselves for a sustainable future is of critical importance. Finding an answer is essential for long term growth of the British economy and the survival of tomorrow's companies.

1.2 The Modern World

Technological developments and the move towards national specialisation have resulted in increased international trade and the growth of multinational companies. Historically countries such as the United States and the United Kingdom have invested in emerging economies. The majority of the investment went towards outsourcing manufacturing in order to gain large cost savings through benefiting from cheap labour and resources.

In recent history, companies from these emerging economies have started to invest in western companies through mergers and acquisitions; in particular companies from the BRIC economies (Brazil, Russia, India and China). Many of the companies in these emerging markets have grown sufficiently through foreign investment to allow them to grow internationally. Through acquisition of companies abroad they have diversified and increased their capabilities. This has resulted in the growth of giant conglomerates from emerging markets.

According to the 2005 report², where the concept of BRICs was coined, the only other economies which resembled the big four were Mexico and South Korea; these were excluded from the original term as they were already part of the OECD. South Korea in particular led the way in this form of international growth, which led to incredible growth in GDP and the growth of a middle class within their economy.

South Korea is now an important economic power and the world centre for several industries, made even more impressive by the state of the Korean economy following the Second World War and the Korean War.

1.3 South Korea

The history of South Korea must be contemplated in order to understand its industrial position in the global economy today.

Although it has a long and dramatic history, the South Korea of today is very much shaped by the period immediately after the Second World War. Before the war, the Korean Peninsula was one unified nation, and had been so for some time, albeit occupied by Japan in the years preceding the war.

² How Solid are the BRICs?, Goldman Sachs 2005 <http://www.goldmansachs.com/our-thinking/topics/brics/how-solid.html>

Following the war, and the surrender of Japan, the country was divided along the 38th parallel, with the north occupied by the soviets, and the south by the U.S. led allied forces. With the failure to hold free elections in 1948, division along the 38th parallel deepened, with political structures dominated by those of the powers who had occupied them.

On June 25, 1950, the Democratic People's Republic of Korea (North Korea) launched a surprise attack on South Korea; the war that ensued lasted three years and took more than 3,000,000 lives.

Following a period of calm after the war, the Korean economy began its expansion in the 1960s. South Korea's real gross domestic product expanded by an average of more than 8% per year, from US\$2.7 billion in 1962 to US\$230 billion in 1989, breaking the trillion dollar mark in 2007, with the manufacturing sector growing from 14.3% of the GNP in 1962 to 30.3% in 1987. The most significant driving factor for this rapid industrialisation was the adoption of an outward-looking strategy in the early 1960s. It was particularly well suited to that time due to South Korea's poor natural resource endowment, low savings rate, and tiny domestic market. The strategy promoted economic growth through labour-intensive manufactured exports, in which South Korea could develop a competitive advantage. Additionally, the inflow of foreign capital was greatly encouraged to supplement the shortage of domestic savings.

In the early 1990s, the South Korean economy continued to show stable and strong growth in both private consumption and GDP. This changed rapidly in 1997 with the Asian Financial crisis and the Korean Won depreciating significantly in October that year. By January 1998, the government had shut down a third of Korea's merchant banks, however actions by the South Korean government and debt swaps by international lenders managed to contain the country's financial problems. Many economists now agree that much of the country's recovery should be attributed to effective labour adjustments and acquisition of alternative funding sources. By the first quarter of 1999, real GDP growth had risen to 5.4%, and strong growth thereafter combined with deflationary pressure on the currency led to a nominal growth of 9.5%.

Like most industrialized economies, Korea suffered significant setbacks during the global financial crisis that began in 2007. Most sectors of the economy reported declines, with manufacturing dropping 25.6% as of January 2009. A contraction of 4.5% was predicted, but South Korea was able to limit the damage of the downturn and avoid recession, reporting 0.32% growth in 2009³.

Despite the global financial crisis, the South Korean economy was supported by timely stimulus measures and strong domestic consumption of products that would compensate for a drop in

³ Source of GDP figures, World Bank

exports. It was able to avoid a recession, unlike most industrialised economies and in 2010 South Korea grew by 6.3%, signalling a return of the economy to pre-crisis levels of growth. The South Korean economy of the 21st century, as a “Next Eleven” economy, is expected to grow from 3.9% to 4.2% annually between 2011 and 2030, similar to growth rates of developing countries such as Brazil or Russia. This prediction further reinforces the original claim that although South Korea is a highly developed country, their economy being more alike to those of the BRICs than its OECD counterparts, it is one to watch, especially in a post-global financial crisis era.

2 Manufacturing

Manufacturing traditionally has been viewed as the use of machines and tools through labour to produce goods that provide a function to an end user. The modern view of manufacturing encompasses a far greater range of direct activities in the process of production itself (component production and integration, industrial design etc.) as well as all supporting activities such as HR, finance, supply chain management etc.

Korea has developed a strong export-led manufacturing-based economy, partly because leaders (both industrial and political) have taken this holistic view and created companies that are world leaders in many aspects of their function, not only production.

In this section we consider the current state of Korean manufacturing: how it got to where it is today; aspects of the value/supply chain that companies participate in and national competencies (using examples from specific leading industries in Korea).

Before we analyse the level of innovation and sustainability in Korea, and how the manufacturing sector in Korea may improve in both categories, we first consider the current manufacturing landscape.

2.1 Recent History & Significant Events Affecting the Manufacturing Landscape

Korea has suffered a difficult history of war and occupation, most recently with the devastating Korean War in 1950-1953. The war served to perpetuate what was supposed to be a temporary division of the Korean peninsula and left a crippled economy and people. However, from the 1960s onwards South Korea has been striving to build its economy, with the aim of becoming a serious global competitor. To achieve this, five-year plans were formulated, designed to increase wealth within South Korea and strengthen political stability. Throughout these five-year plans, starting in 1962, a shift in policy from import substitution industrialization to export-oriented growth occurred.

Starting from a predominantly agricultural background, the first five-year plan from 1962-1967 focused on increasing the textile industry to make South Korea more self-sufficient in clothing its citizens. Subsequent five-year plans, from 1968-1977 sought to shift the South Korean state into heavy industry with a big push into Heavy Chemical Industrialisation (HCI). The opening up of the Chinese and USA markets in 1972 benefited this move by creating a greater competitive market place for South Korean exports but to fund this the government borrowed heavily from foreign

POSCO was founded as a state company in 1968 after the South Korean government concluded that the ability of South Korea to manufacture its own steel as a crucial factor in the economic growth and development of the country. The POSCO site in Pohang began steel production in 1972, becoming South Korea's first modern steel plant and is now the largest steel mill in the world by market value. POSCO was privatised in 2000 and has expanded operations to a second steel mill in Gwangyang, a stainless steel mill in Jiangsu Province, China, and also currently has a joint venture with U.S. Steel in Pittsburg, USA.

countries which led to vulnerability in later financial climates. Milestone achievements of South Korea's rise include the discontinuation of rice imports in 1976 and the celebration of achieving \$10bn exports in 1977. As a resource poor nation, with limited arable land, being able to provide enough food had been a long term goal for many years⁴.

Manufacturing companies in South Korea are vertically integrated for heightened value-add and there is now a growing trend towards more ethical, responsible brands across the value chain. Key manufacturing industries that have recognition in the global arenas include shipbuilding, electronics, automobile, construction, textiles and chemicals.

2.2 Manufacturing & the Chaebols

The *Chaebol* is the most widespread form of conglomerate in South Korea. They are each majority owned and controlled by individual families. Only in recent years have managers that are either from outside the direct family and/or foreign been appointed to senior positions. The government has played a central role in the strengthening of the Chaebol, with tax incentives, subsidies and other preferential treatment given in the past to speed up industrialisation of South Korea. Due to their success their influence now stretches beyond the economy and into political life, with many Chaebol heads taking seats in public office.

All Chaebols started as single businesses, which expanded sequentially into related fields and so became vertically integrated organically. With cheap credit (often with negative real interest rates) and other incentives from the government they also expanded horizontally into totally unrelated fields as well. For example, Samsung started as a grocer, became a large wool mill then a trading company, finally moving into electronics, shipping and ship-building. Some have criticised the Chaebol system and see it as a threat to the sustainability of the South Korean economy, with all candidates for the up coming presidential election in Korea unanimously promising to reign in and control the Chaebols if they take up office.

⁴ Korea having 16.58% arable land as opposed to 23.23% in the UK (Source: CIA World Factbook)

Although Chaebols have provided Koreans with a vastly increased standard of living, perhaps the greatest argument against the Chaebol system is the sheer scale of dominance over the Korean economy, with a growing popular political movement towards economic democratisation. However, with the Chaebols' strong influence and increasing competitiveness, manufacturing techniques are being developed to lower production costs or improve quality, thereby advancing the industry. All the Chaebols visited have recognised the need to develop sustainable products and technologies, and many have started moving into selling "green" products, some even opening dedicated R&D centres in this area. Furthermore, this increasing diversification and development of technologies by the Chaebols has opened up new opportunities in the supply chain. The combination will develop the manufacturing sector as a whole, not only in South Korea but globally as well.

2.3 Major Industrial Sectors

Korea participates across all industrial sectors. Here we focus on the top three by contribution to GDP as examples of Korean competitiveness.

2.3.1 Electronics

In 2009, the consumer electronics market had revenues of 4.6 billion USD, with the Audio Visual Equipment segment accounting for over 94% of this⁵. The most important electronics companies are Samsung, LG and Hynix. These companies manufacture a range of electronic products including mobile phones, semiconductor chips, displays (both for smart phones and TVs) and tablet computers. Samsung and LG's similar strategies to be fast followers seem to have awarded them success. LG displays claims to have 'bargaining power' with their clients and Samsung smartphones are top competitors (and until recently suppliers) to Apple's iPhone⁶. The Japanese earthquake has had a favourable impact on demand for Korean electronics as clients of Japanese firms look for alternative suppliers.

2.3.2 Shipbuilding

South Korea is the global leader in the production of advanced high-tech vessels such as cruise liners, super tankers, LNG carriers, drill ships, and large-sized container ships. Hyundai Heavy Industries, Samsung Heavy Industries, and Daewoo Shipbuilding & Marine Engineering dominate the industry, in Korea and globally.

⁵http://www.datamonitor.com/store/Product/consumer_electronics_in_south_korea_industry_and_country_analysis?productid=2E9D0949-AEA8-4B54-B303-CD6CBEFE5628

⁶ http://www.koreatimes.co.kr/www/news/tech/2012/01/129_86051.html

During the global economic boom years between 2003 and 2007, companies bulked up rather than invested in new technologies. All have been hit hard by the global financial crisis with new orders falling globally by 40% in 2008 (Greece currently owns 15% of the world’s vessels, while the French shipping company CMA CGM, which was the third largest in the world, went into administration). South Korea was not hit as badly by the global crisis, new orders fell by 20% with market share rising by 11.7% due to high efficiency and lower reduced costs than Western shipyards. In the 3rd quarter of 2011, South Korea won all 18 orders for LNG carriers, 3 out of 5 drill ships and 5 out of 7 large-sized container ships. It appears that South Korean companies are likely to dominate vessel construction for the oil & gas sector over the coming years. However, China is a rising threat due to low wages and high government support, with Japan now trying to make a comeback as the former world leader by aggressively co-operating with China.

2.3.3 Automotive

The automotive industry in South Korea is currently the fifth-largest in the world measured by automobile unit production and the sixth-largest by automobile export volume. South Korea produced a total of 3.513 million vehicles in 2009 (5.7% of global production). Hyundai Kia Automotive Group is the biggest automaker in South Korea.

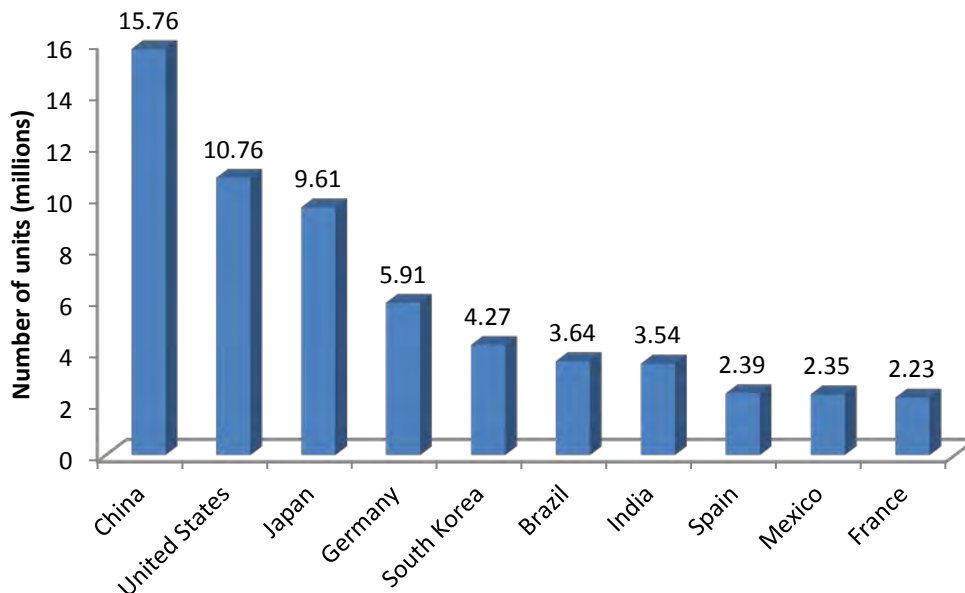


Figure 1: World Top 10 Automotive Producers
<http://www.businessvibes.com/sites/default/files/top%2010%20automotive.jpg>

Case Study: Woongjin Energy

Woongjin Energy was formed in 2006 as part of Woongjin Holdings. The company specialises in the manufacture of silicon ingots and wafers, mainly for the production of photovoltaic (PV) systems by their customers. The company has managed to secure a contract with Sun Energy, manufacturers of the world's most efficient PV systems.

The ingot manufacturing process is based on traditional production methods, however Woongjin have developed unique quality control technologies to achieve high quality products at all customer specifications.

Polysilicon raw material and dopants are melted together under very controlled conditions; Woongjin owns 200 ingot ovens which provide a high level of automation to the manufacturing line. Only one operator is needed for every eight machines, meaning that labour costs are low. Once the melt is ready, a probe is dipped in the melt and slowly pulled out to form the neck of the ingot; this starts the long ingot-forming process which consists of various stages including shouldering and body growing. Once the ingot is formed, it is extracted from the ingot manufacturing cell and left to cool down. Additional slabbing processes are then carried out to produce the required shape, size and finish.

2.4 National Competencies

When seeking to identify South Korea's competitive strengths in the manufacturing sector, it may be of use to consider the concept of 'national competencies'. A national competency is an attribute of the national manufacturing industry that enables businesses to respond to the changing global trends and drivers in a way that captures value for national economy in the future⁷. Deloitte and the US council on competitiveness annually rank nations on their manufacturing competencies⁸ based on the drivers in Table 1, which are thought to be key to maintaining competitive advantage in manufacturing. It was noted that manufacturing drivers in the Far East differ slightly from those in other more economically developed countries (MEDCs):

"Asian executives do see government investments in manufacturing and innovation as critical — ranking it the second most important driver for manufacturing competitiveness."

In contrast, for European companies, government investment is ranked 8th of 10; this is indicative of the free-market non-interventionist policies of many European governments, including that of the UK. Although in the past the Korean government has heavily supported industry, most notably the provision of extremely low interest rate loans for large businesses which helped grow the Chaebol, on visiting several firms most expressed the view that monetary support from the government was, in fact, very low. The government does, however, seem to be investing heavily in the infrastructure required for successful future business (see case study on the Seoul environmental cluster, p30). Transport links within the country and information communication infrastructure are also being developed, and accelerated with the growth of science parks.

⁷ *A landscape for the future of high value manufacturing in the UK*, Gregory et al 2012.

⁸ http://www.deloitte.com/assets/Dcom-Global/Local%20Assets/Documents/Manufacturing/dtt_2010%20Global%20Manufacturing%20Competitiveness%20Index_06_28_10.pdf

One significant science park is Taedok⁹, located 150km south of Seoul, 280km north of Pusan and 170km from Kwangju¹⁰. Korea has also invested heavily in high speed rail links, air travel (including the Incheon Airport built on reclaimed land) and road links to many of Korea's Islands by impressive bridges and tunnels.

Asia – Manufacturing Competency Drivers	Rank
Talent-driven innovation	1
Government investments in manufacturing & innovation	2
Cost of labour and materials	3
Economic, trade, financial and tax systems	4
Energy cost and policies	5
Quality of physical infrastructure	6
Legal and regulatory system	7
Supplier network	8
Local business dynamics	9
Quality and availability of healthcare	10

Table 1: Manufacturing Competency Drivers (Deloitte)

The only driver ranked higher than government investment in the Asia region was “Talent-driven Innovation”, and nowhere is this clearer than in Korea. The Korean education system, especially pre-university, is intense and highly pressurised. Students wake early to study before school and then study late into the night, day after day to attain a place at one of the best universities. There is an aspiration to work for the best firms among the workforce, the best firms can therefore take their pick and may only take people from a small selection of universities, which in turn will only take the best high school students. This combined with a strong Confucian influence within Korean society - the belief that human beings are teachable, improvable and perfectible through personal and communal endeavour, especially self-cultivation and self-creation - has the result that the general level of education is exceptionally high.

Large Korean firms realise that their strength comes from their people, and will go to great lengths to recruit the best. Samsung are actively beginning to look outside of Korea for the best talent, which is a relatively new trend, demonstrated by the appointment of David Eun (U.S. national and formerly of AOL and Google) to the position of Executive Vice-President. Until recently the idea of a non-Korean on the board of a Chaebol company would have been unheard of; but this shows that

⁹ <http://www.chinapost.com.tw/business/asia/korea/2012/05/26/342312/Seoul-stands.htm>

¹⁰ <http://park.org/Korea/Pavilions/PublicPavilions/Government/most/taedok.html>

the hiring of foreigners at board level in areas Chaebols do not previously have significant experience in (in this case global media) is now open for discussion.

Examples of these Manufacturing Competency Drivers in Korea's largest industrial sectors – Electronics, Shipbuilding and Automotive – are detailed below.

2.4.1 Talent Driven Innovation

2.4.1.1 Electronics

Korean companies support cutting edge research and development projects, collaborations with foreign organisations (over 27 R&D centres in the USA) and science and technology programmes at leading academic institutions worldwide. This has led to these companies being world leaders in not only production but new technology and innovation as well. Education is seen as key to supporting continue growth in the electronics industry to prevent having to buy in technology and expertise from abroad.

2.4.1.2 Shipbuilding

When South Korea was first establishing its shipbuilding industry they were in a similar position to that in which China now finds itself¹¹, importing the vast majority of the technology upon which the industry was based from Japan. However, they are now seen as a leading innovator in the process of shipbuilding, although not necessarily in naval architecture, where European shipyards and designers still believe they have an advantage¹². Samsung Heavy Industries now extensively uses floating docks rather than dry dock for larger projects. South Korea recognises the need to support innovation in design of products as well as processes and is investing heavily in recruiting (both domestically and from India) and training naval architects (courses are available at all of the top 10 universities). However, the balance of product innovation and technology research is still concentrated in Europe and Japan.

2.4.1.3 Automotive

As in shipbuilding, Korea has become a leader in process innovation in the automotive sector. According to South Korea's Chosun Ilbo reports, South Korea's five automobile companies sold 5.44m units worldwide in 2009, with only 3.5m units produced at home: manufacturing innovation expertise is being exported and no longer imported as factories are increasingly established abroad.

¹¹ http://www.chinadaily.com.cn/bizchina/2010-09/09/content_11281339.htm

¹² <http://ec.europa.eu/research/brite-eu/thematic/html/3b-1-05.html>

Case Study: Hyundai Heavy Industries

Hyundai Heavy Industries' Ulsan shipyard is the largest shipyard in the world, covering 1780 acres with 2.5 miles of coastline. The yard has nine large-scale dry docks, with six Goliath cranes, allowing them to manufacture any type of ship at any size.

Korea's dominance of the global shipbuilding industry is based on excellent quality and the ability to manufacture ships faster and cheaper than other nations. The Hyundai yard at Ulsan was established in 1972, based on an approach to shipbuilding developed by A&P Group in the UK. The established European shipyards of the time had rejected the idea that manufacturing principles of process flow should be applied to shipbuilding but Hyundai was prepared to take a chance on the new technology. Today the Ulsan yard commands about 16% of the global market, while most UK shipyards went out of business in the '80s and '90s. Hyundai maintain a willingness to invest in new technology; fully automated steel cutting lines, a forge, welding robots and an eco-friendly paint shop can all be seen at Ulsan.

Hyundai are keen to maintain their lead in marine systems with increased production of oil and gas facilities covering the current global slump in ship demand; as with their recent moves into the wind energy industry, the company looks to leverage its core competencies in large scale steel fabrication and manufacturing efficiency in related sectors to fuel growth. However, they recognise shortfalls in some areas, particularly design and materials research, and are actively investing in technology and personnel to increase their strength going forward.

Worldwide Sales 2009	
Hyundai-Kia	4,641,756
GM Daewoo	578,758
Renault Samsung	189,813
Ssangyong	34,936
Total:	5,445,263

Table 2: Worldwide Automobile Sales Volumes 2009

2.4.2 Government Investment

2.4.2.1 Electronics

Government policy has traditionally supported the Chaebols, but has broadened the scope of their influence to smaller manufacturers as well since the 1990s. The 'Electro-21' program provided subsidies for electronics technology development, G7 funds were available for research and the Engineer Training Institute was geared towards manufacturing and engineering skills training. Also, employees in companies that contribute to the defence sector are eligible for military service exemption¹³. The government is working in partnership with local firms to adapt the structure of the chip manufacturing industry to more closely match world consumption¹⁴.

2.4.2.2 Shipbuilding

The South Korean Government has continually invested and supported the industry for decades. The bank of South Korea has issued guarantee letters for shipyards and the Import/Export Bank of Korea was established to provide loans to shipyards at reduced rates¹⁵. In 2001 an investigation into subsidies paid by the South Korean government to support shipbuilding found that they were in violation of the World Trade Organisation's 1994 subsidies agreement, but the government denied any influence over the shipyards. The European Commission found that state aid to shipyards included 2600 million EUR to Daewoo and 1700 million EUR

¹³ http://www.wtec.org/loyola/em/02_06.htm

¹⁴ <http://www.frost.com/prod/servlet/report-brochure.pag?id=4648-01-00-00-00>

¹⁵ <http://www.indiandefencereview.com/military-and-aerospace/India-Lags-Behind-in-Shipbuilding.html>

Case Study: Hyundai Motor Company

The Hyundai Motor Company, part of the Hyundai group, is comprised of Hyundai and Kia which together are the world's 4th largest automobile company producing close to 4 million cars per year.

The Hyundai plant at Ulsan is the world's largest car plant producing 1.54 million cars annually. Across the five production lines at the site, one car is produced every 12 seconds! Production lines are split by general vehicle type (e.g. SUVs, saloons). However, small cars such as those popular in Europe are labour intensive and therefore manufactured in India where costs are lower.

Hyundai manufacture only the bodies, transmissions and engines of their vehicles; all other components are purchased, although 95% of these are from within South Korea. Different parts of production have different levels of automation, for example, body assembly is 95% automated whereas only 10% of the final assembly is automated.

The plant's onsite port is capable of handling 3000 cars per day which is essential as 83% of all South Korean manufactured cars are exported. Of these, 10% go to Europe however Hyundai still controls a massive 80% of the domestic market!

to Sambo, again in violation of free trade agreements¹⁶. In 2002 South Korea announced that a further 170 million USD would be invested into shipbuilding R&D over the next ten years in spite of international pressure to reduce capacity. Certainly it appears that Korean shipbuilders are in a favourable position when it comes to government backing, and this has helped them out-compete Japan and Europe; this is currently grounds for declaring a national competency in this area. It remains to be seen whether China, with a faltered history of complying with free trade regulations, will beat the South Koreans at their own game.

2.4.2.3 Automotive

The South Korean government has shown consistent commitment to the automobile industry and has played a tremendous role in sustaining in. The government backed up the automotive industry with a variety of policies, which laid the foundations for collaboration among innovation actors. In fact, the success that the South Korean automobile industry, as a world's late entrant, achieved over the past decades was only possible due to the brisk cooperation among government, industry, and academia.

This cooperative relationship is also unmistakably demonstrated by recent government initiatives. For instance, the South Korean government invested 400 million USD in the Ulsan Auto Valley Project (Prativedwannakij 2009). Under this project, the Ulsan Metropolitan City continuously supported Hyundai-Kia Motors as a production base, which reflects the close relationship between government and industry.

2.4.3 Cost of Labour and Materials

Korea is able to operate at a cost advantage in terms of labour rates compared to other developed nations, particularly Japan, the US and Europe; however, China operates at a cost advantage compared to Korea. Although Korea is in the world's top ten steel producers (the primary material in ship construction) it has little in the way of viable indigenous iron ore reserves¹⁷ and, as such, it is

¹⁶ <http://www.globalsecurity.org/military/world/rok/industry-shipbuilding-5.htm>

¹⁷ <http://www.mapsofworld.com/minerals/world-iron-ore-producers.html>

vulnerable to supply disruption which would affect both the shipbuilding and automotive industry. Korea lags behind all three of its major competitors in annual output with Japan producing double the tonnage of steel in 2010 and China producing 12 times as much, more than the rest of the top ten combined¹⁸! The automotive industry consumes one third of Korea's rubber. Highly specialized labour and technologies that have been developed in the automobile industry are now used in other similar manufacturing industries, such as shipbuilding.

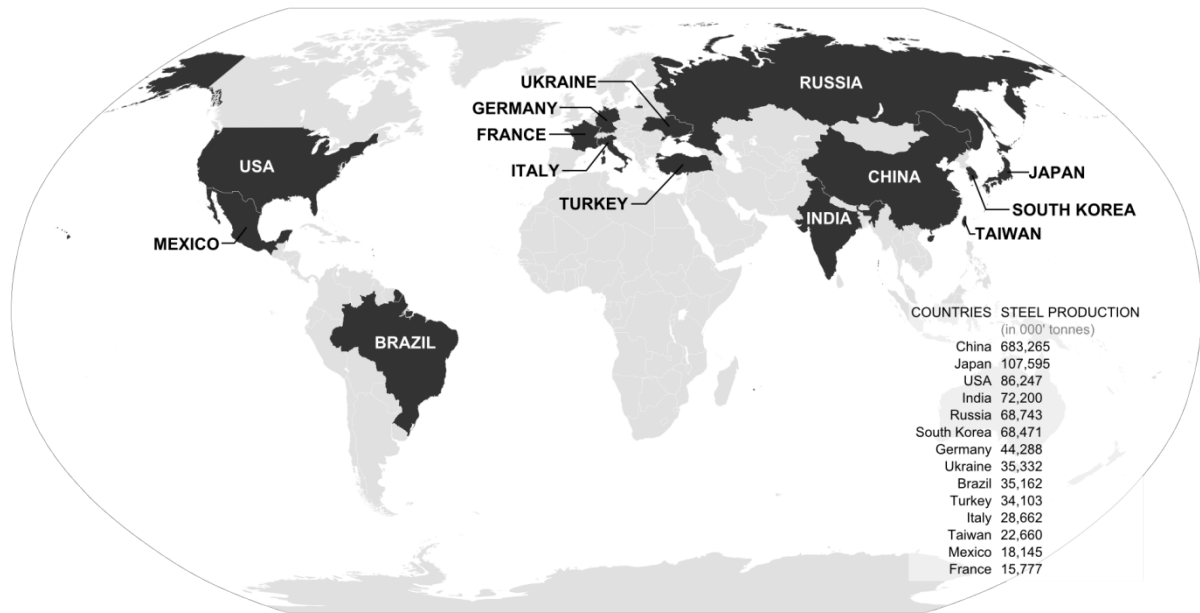


Figure 2: World Major Producers of Crude Steel

2.4.4 Economic, Trade, Financial and Tax systems

In 1994, Korean import tariffs on passenger cars were reduced to 10%; however, even though the barriers have been removed, only high-end foreign cars have penetrated the domestic market. Over the years, stories of government and press intimidation have been persistent. By far the most feared is the threat of a tax audit when purchasing a foreign car, though a variety of other methods have been used to discourage the purchase of imported cars.

2.4.5 Physical Infrastructure

The Korean government plans to establish a sustainable charging infrastructure for electric vehicles. The government will invest 111 million EUR in building the charging infrastructures by 2020

¹⁸ <http://www.worldcoal.org/resources/coal-statistics/coal-steel-statistics/>

(Virtanen/Lee 2010). These policy measures recently coordinated demonstrates that the government as a public actor plays an essential role in bolstering the automobile industry.

2.4.6 Legal and Regulatory System

2.4.6.1 Shipbuilding

The International Maritime Organization (IMO) will likely regulate CO2 emissions through a greenhouse gas (GHG) fund starting in 2015 by forcing shipping firms to trade carbon credit. For example, a shipping line with poor fuel efficiency should pay 450 dollars for bunker prices as well as 150 dollars for carbon tax imposed by the GHG fund.

The fund gives the received carbon tax to other shipping firms with better fuel efficiency as incentives. All in all, fuel-efficient shipping companies pay only 300 dollars with the help of 150-dollar incentive while non-fuel-efficient companies pay 600 dollars for fuel prices and carbon tax.

2.4.6.2 Automotive

The Korea Automobile Manufacturers Association, or KAMA, is a South Korean automobile and motor vehicle association. KAMA is a non-profit organization, representing the interests of automakers in Korea. It has the following roles:

1. Representing the interests of Korean automakers through providing policy recommendations to the government for improved auto-related systems and regulations.
2. Promoting international cooperation with major trading counterparts, administering trade-related systems and representing members in international forums.
3. Facilitating environmental and safety-related policy and regulations.
4. Promoting consumer satisfaction and fair trade.
5. Leading public opinion on automobile industry and promoting PR.
6. Analysis, research and data publications.
7. Organizing the Seoul Motor Show.

2.4.7 Supplier Network

2.4.7.1 Shipbuilding

Korean shipbuilding companies tend to source the majority of their components internally, particularly in the case of the Chaebol with such suppliers integrated into the conglomerate. Smaller shipyards tend to source some of their components on the global market¹⁹. There are 153 registered

¹⁹ <http://www.oxbridgewriters.com/essays/management/the-shipbuilding-cluster.php>

ship machinery and equipment companies in Korea, which account for 70-80% of the components. A large proportion of these suppliers also provide products to the global market, their largest customers being Japan and the EU. Steel is also typically sourced internally; POSCO is the largest steel supplier, although the vast majority of iron ore is imported.

2.4.7.2 Automotive

China was the biggest export destination and import source for South Korean cars in 2010. 23.2% of South Korea's total exports headed to China and 16.8% imports were from China. According to China Auto Net, China imported 173,654 vehicles from South Korea in 2010. The table below shows partnerships between Korean and foreign automotive companies including cross-licensing and fractional ownership agreements.

Korean Company	Foreign Company	Year	% of Foreign Ownership	# of Cars Produced	Type of Agreement
Hyundai	Ford	1968	-	-	Assembling Ford's cars & training for engineers
Daewoo	GM	1972	50	-	Joint venture
Kia	Mazda	1974	-	-	Assembly of Mazda cars
Hyundai	Mitsubishi	1979	-	-	Access to technology license
Hyundai	Mitsubishi	1982	10	300,000 units p.a.	Access to technology license
Daewoo	GM	1984	50	167,000 units p.a.	Joint production
Hyundai	-	1985	-	-	54 license agreements signed
Hyundai	Mitsubishi	1985	2	-	
Daewoo	GM	1985	50	Parts	Joint venture
Kia	Mazda	1986	8	-	FDI
Kia	Ford	1986	10	50,000 – 75,000 units p.a.	FDI
Ssangyong	Mercedes-Benz	1992	5	150,000 units p.a.	FDI
Daewoo	Siemens AG	1996	40	Parts	Joint venture
Hyundai	Ford	1968	-	-	Assembling Ford's cars & training for engineers
Daewoo	GM	1972	50	-	Joint venture
Kia	Mazda	1974	-	-	Assembly of Mazda cars
Hyundai	Mitsubishi	1979	-	-	Access to technology license

Table 3: Table detailing Cross-licensing between Korean and Foreign Automotive producers²⁰

²⁰ Linsu Kim, *Imitation to Innovation*, Harvard Business School Press; Business Korea, December 1983; J. Yang, *History of Korean Automating*; The New York Times, June 1984; Dow Jones Newspapers, September 1985; The Asian Wall Street Journal, April 1996; The Wall Street Journal, July 1986; The Wall Street Journal, February 1993

2.4.8 Local Business Dynamics

2.4.8.1 Shipbuilding

A large amount of restructuring has taken place for small shipyards over the last few years, caused by a strong outlook for small ships stemming from huge upcoming replacement demand in the global fleet²¹. Due to the large capital costs of facilities to handle the largest ships, there are few manufacturers competing in this space, the small/medium ship categories are much more competitive. There is also a current trend to promote fuel efficiency and low greenhouse gas emissions which benefits the smaller ship classes, leading to increased orders.

2.4.8.2 Automotive

There exists a view among certain Korean consumers that the Korean auto industry stands – and has always stood – alone, unaided by the global automotive industry, a bastion of industrial strength, crucial to the economic survival of the country. Therefore, as noted earlier, buying an imported car is seen to be unpatriotic and indulgent. Past government and media rhetoric made it clear that imported goods endangered a healthy balance of payments situation, putting the economy and its growth at serious risk.

The J.D. Power report, “Consumer attitude towards import cars in Korea,” cited four reasons given by Korean consumers for not buying imported cars:

1. Detrimental to national interest,
2. Leads to social disparity,
3. Reception of “dirty looks” from peers,
4. Considered to be an unnecessary luxury.

Those consumers who had purchased Korean cars were most worried that buying an import would be detrimental to the national interest and would provoke “dirty looks” from peers.

2.5 Conclusions

Overall, manufacturing in Korea is in a healthy state and has weathered the recent crisis well. Its past growth and current scale are all primarily due to the macroeconomic policies of the past. The Korean economy is a prime example of a successful centrally-led, government directed economy. It breaks many of the rules and theories drawn up by Western free-market economists and runs contrary to

²¹ http://news.xinhuanet.com/english2010/indepth/2011-02/07/c_13721505.htm

the Washington consensus, which has driven Western ideology and policy for a generation. Protection was given to emerging industries to allow them to catch up with established competitors while efficiency was gained through export led growth and not through high levels of competition within the internal market. (This original reliance on imports actually resulted in the birth of the now mighty Korean ship building industry.)

The stability provided by this model was essential to generate the long period of rapid growth in manufacturing industrial sectors in the decades following the devastating Korean War. These protectionist policies of the past however are now being removed as Korea signs FTAs with nations around the world and both companies and countries turn to legal routes to ensure fair competition on a world stage. Business and politics are becoming more open with internal and external pressure to change. The established order of the Chaebol system is now seen as a headache from the past by many commentators and reform, for better or worse, will occur.

All of this, along with the other challenges faced by all manufacturers of sustainability and innovation, place Korea's manufacturing sectors at a critical point in their development. The old models for growth and acting as fast followers to catch up with industry leaders can no longer be followed at a time when many Korean companies are the industry leaders. Long term growth must now be achieved through innovation, with many of the companies we saw expanding into the clean tech industries and developing more energy efficient and sustainable products.

Not everything is going to plan however: Korea's late push into the polysilicon and solar PV sector has faltered, with major investments and plants cancelled this year. The traditional big push from Chaebols and the government may no longer be sufficient to enable companies to enter new industries. Instead companies, such as Woongjin, have bucked this trend through process innovation, allowing them to survive where others have failed. The national pride of the country has also been hit by the recent litigation between Samsung and Apple, with Apple overall coming out on top and any ruling against Samsung seen as a dishonouring of Korea itself.

Despite these setbacks, few question that Korea is likely to grow in importance as a global manufacturer, with its brands and products gaining greater market share and out competing others on cost, quality and innovation.

POSCO is one of the world's leading steel producers. Set up after the Korean War to provide industry for the country, it is now located on two sites producing hot rolled, cold rolled, plate, billet, wire and stainless steel and employs 17,000 people.

POSCO has a strong focus on creating an environmentally friendly business, particularly recognising the scarcity of resources with most of their raw materials imported. Their slogan across the Pohang site entrance reads 'Resources are limited, creativity is unlimited'.

Due to stringent environmental standards and rare raw materials, POSCO use an innovative process called FINEX for some of their steel production. Developed with other companies, this process technology reduces sulphur dioxide by 3%, nitrogen oxides by 1%, dust by 28% and operating costs by 15%.

As well as using a more environmentally friendly process technology, they are aiming to improve the eco-friendliness of their products by removing harmful substances and extending their lifetime. They have several initiatives in place to reduce the impact of the Pohang site. This includes planting trees in the area to create a green belt, using waste gas in a power station, treating waste water and collecting dust from the process. They have an environmental centre monitoring pollutants 24 hours a day and recycle 98.5% of the by-products from the Pohang site, for example using slag in cement.

3 Sustainability

Sustainability is a word that appears in many forms and places these days. While many organisations realise it is important, few have an all-encompassing definition of the term. For the purpose of this report, a company's sustainability is defined as the ability to endure changing technical and economic circumstances, as well as coping with other social, environmental, political and infrastructural variations, whilst maintaining operating activities, working relationships, company ethos and external relations. It implies a consciousness of one's impact on the environment, and consideration of the existing and future needs of others.

3.1 Korean Focus

From the companies visited, there was little evidence of government initiatives being a driving force behind a change to become more environmentally sustainable. In most cases, the preferences of the customer (both individuals and businesses) were the reason behind initiatives taken. Government involved projects, such as the SLC (see case study on the Seoul environmental cluster, p30) and the Korean Climate Change Centre, demonstrated intelligent, environmentally friendly ideas but these ideas were not widely adopted in industry. Few companies used renewable energy on site, however this may increase as utility companies increase their purchase of renewable energy in order to meet the 'Renewable Portfolio Standard' government initiative. This standard obligates utility companies to produce 10% of their power from renewable sources by 2022 from 2% in 2012.

As opposed to the UK where most companies place emphasis on their environmental initiatives, in Korea the minority of companies visited did so. Most companies displayed some environmental focus on questioning but in some cases sustainability seemed unimportant, particularly in

Case Study: AmorePacific

AmorePacific is the biggest manufacturer of cosmetics and similar FMCG products in Asia. In the fiscal year to 2011, group sales exceeded £1.4bn and operating profits were £210mn.

The approach to sustainability is driven by customers; demand for more sustainable, fairer products is high. In response, the company is committed to 10% annual growth in the number of sustainable products and a 5% year-on-year reduction in production greenhouse gas emissions. They are extending their philosophy along the supply chain, working with suppliers to improve their sustainability and establish fair trade agreements. At the Seoul Beauty Campus, 5-10% of production energy is provided by solar panels, and a rainwater harvester is in operation. Delivery vehicles have been fitted with an auto-start/stop mechanism and are rated depending emissions levels. They have also considered product end-of-life; customers can return used bottles to the company in exchange for points which can be redeemed against future purchases, whilst the bottles are sterilised and refilled in the factory.

comparison to the importance of global growth and the long-term stability of the company. However, there were some companies with a strong focus on being eco-friendly, particularly Amore Pacific (see case study) and POSCO. These companies made a point to note their environmental initiatives during the tours and some provided environmental reports. Across the companies, the environmental focus was mainly on the technology within the products as well as emissions. A key green technology producer was Samsung electronics where their eco-products were estimated to have saved 7,388,862 tonnes of CO₂e in 2010. However, other green initiatives did not seem to be prevalent within the company.

3.2 The Question of Consumption

The populations of developed countries have become accustomed to mass availability of products and services. However, mass availability requires mass production, which incurs mass resource-usage and emission of pollutants. In an ideal future, every person on the planet will be able to enjoy the standard of living that has become expected in the West. However, this implies global mass consumption, which means increasing resource demand and emissions. With resources essential to the provision of this living standard becoming increasingly scarce, it seems that this vision is unachievable, and certainly not sustainable.

The question is how to sustainably align the quality of life of the developing world with that of the developed world. It is clearly unethical to deny developing populations this chance because the West has already used everything the Earth has to offer. It is likely, however, that the populations of the developed world will have to adjust their expectations, and compromise in order to distribute the wealth of the Earth fairly and sustainably. This report cannot provide a solution to this problem, but it is important to question the sustainability of the consumption that we see

around us today, as the first step in affecting a change in attitude.

Case Study: Doosan Heavy Industries

As one of the largest Korean heavy industrial companies, employing roughly 7000 people on a 4.5 million square metre site in Changwon, Doosan strives to lower its environmental impact through a sense of responsibility. Doosan operates in many industries, in particular energy generation and water purification.

Earning a 'World Class Product of Korea' status for the advanced Heat Recovery Steam Generator, Doosan reaps the rewards from extensive research in each industry. The development of the WinDS 3000™ offshore wind turbine and testing of a pure oxygen combustion 70MW coal fired thermal power plant further demonstrate Doosan's commitment to green energy production. Doosan has helped develop desalination technologies to provide large volumes of water to areas most in need, with large activity in the Middle East.

There are currently three core technologies used by Doosan which are selected depending on requirements and conditions of each location: Multi-Stage Flash, Multi-Effect Distillation (MED) and Reverse Osmosis. The MED process is unique in that evaporation takes place in a vacuum, allowing the sea water to be boiled at lower temperatures both increasing the efficiency and reducing the power required for desalination.

3.3 Sustainability of Conglomerate Economies and the Chaebols

3.3.1 Definition of Conglomerates

A conglomerate is a combination of two or more corporations engaged in entirely different businesses that fall under one corporate structure. Conglomerates became popular in the West following the end of World War II, as industrialists began assembling companies under a holding company in order to reduce the risk carried by investors. By combining companies operating in different industrial sectors, an unfavourable business cycle for one company can be counter-balanced by a favourable business cycle of another, and the overall corporation is at less risk. Conglomerate economies are often thought of as a fad for business operations and the concept of a conglomerate is sometimes not considered to be a sustainable business model. Conglomerates that have been sustainable are those that have carefully kept track of the performance of subsidiaries and been proactive in buying and selling of companies to keep the overall conglomerate as lean as possible.

3.3.2 Success Conditions for Conglomerates

Certain economic conditions are conducive to the success of conglomerates. Forming a conglomerate is a good option when acquisition competition is low and the conglomerate has the required human resources to run its acquired companies. A conglomerate is likely to grow rapidly during periods of low interest rates, as they can borrow cheap capital to fund acquisitions, whilst using the acquired company assets as collateral, in leveraged buyouts. This practice allows the value of the conglomerate to increase, resulting in a large return on investment (ROI). If the interest rates rise, however, the profitability of the investment decreases dramatically.

Case Study: Woongjin Energy

Specialising in the creation of high-quality silicon ingots and solar-panel grade wafers, Woongjin Energy uses both energy and resource intensive processes. Of their range of processes, the two most intensive are ingot drawing and solar-grade wafer preparation, with ingot drawing being very energy intensive and wafer preparation creating significant volumes of waste as well as requiring large volumes of water.

When dealing with how its activities impact the environment, Woongjin Energy approaches with a three-stream approach of reducing, recycling and reusing. Applying this to its two main processes, efficient floor layout and advanced monitoring is used in the ingot drawing process to minimise the energy used while recycling of used water and silicon off-cuts is practised in the wafer preparation process. On top of this the choice of process also considers environmental issues, with mechanical processes being favoured over acidic ones in wafer preparation and thereby lessening the toxic waste by-products produced.

Aside from these core technologies, Woongjin Energy's factory also follows other environmental practises to reduce its environmental impact. To reduce energy used a mixture of efficiency and renewable sources are used. Efficiency gains are made from low level utilities such as lighting to ensuring manufacturing processes are monitored to optimise energy use, while renewable energy is sourced from heat pumps and photovoltaic panels. To further reduce energy water is re-used to reduce the energy required for cooling and waste heat from processes is directed towards heating in other parts of the plant. Waste in a range of forms is recycled to reduce material costs, with quartz, silicon and other materials from the manufacturing process captured and reused as feedstock, and to make any waste produced less impactful on the environment harmful chemicals such as acids are avoided in the production process to prevent toxic by-products being produced.

Conglomerates thrive in environments where there is little regulation and lack of a comprehensive capital market. The reputation of a much larger conglomerate benefits an acquired company and it is likely to gain a competitive advantage over other small companies operating in the same sector. A country without a developed capital market often has difficulty distributing resources to businesses efficiently. A conglomerate takes on this role, creating an internal capital market to distribute funds to acquired companies. Outside of the Western world, there are many conglomerates that are help up as examples of success. It may be of interest to compare two from outside of Korea, Tata of India and Mitsubishi from Japan, as examples of how others have developed. These examples can be found in Appendices 8.1 and 8.2 respectively.

3.3.3 Failure Conditions for Conglomerates

On the whole, conglomerate economies have limited success; most conglomerates experience disaggregation into smaller divisions or companies. The core reasons for failure tend to be related to the overall size of the corporation. Many conglomerates simply become too big to manage, with numerous layers of management adding costs to the extent that business profitability ceases. Conglomerates tend to disclose consolidated information and accounts, so the performance of each individual company is not disclosed. This makes it harder for both investors and holding company managers to decipher which companies are performing well and which are a drain on resources. The sheer scale of the accounts makes them very difficult to analyse, and can lead to the management hiding problems with creative accounting. This can lead to investor distrust of conglomerates and an eventual fall in share price, leading to a lack of capital for future acquisitions.

Case Study: Environmental Cluster

Sudokwon Landfill Site Management Corporation (SLC) are responsible for the running of an environmental cluster located near Incheon. The site comprises of a landfill area built upon land reclaimed from the sea, and a waste processing plant which converts household waste into combustible pellets which are sold as a solid fuel. SLC was founded in 2000 as an affiliated corporation with the Ministry of Environment, and has since become a privatised corporation. There was initially large opposition to the landfill site from local residents, although SLC has integrated well into the community by sharing the fees paid for dumping waste with the local community and by providing jobs for the surrounding area.

Household waste containing no recyclables is delivered to the site where it is automatically categorised into combustible and non-combustible waste. Non-combustible waste is sent to landfill, whilst combustible waste is processed into pellets which have an energy content of 3800 calories. In comparison, a pellet of coal of the same weight would have an energy content of 4000 calories. The cost of producing waste pellets is greater than the cost of coal, yet due to subsidies paid by the companies who dispose of the waste, the processed pellets can be sold as a substitute for coal at a lower price.

The landfill is constructed in layers, separated by layers of soil and intertwined with a complex system of pipework. The gases that are produced by the decomposing waste are collected, and burned to generate enough electricity for 180,000 homes. The leachate that drains off from the landfill has potential to pollute the surrounding environment, and a water treatment plant onsite processes this leachate to render it safe to the environment.

3.3.4 Conglomerates and the Chaebols

The economic climate in post-war South Korea provided the perfect environment for conglomerate-type businesses to prosper. With the country struggling to rebuild itself after the Japanese occupation, World War 2 and the Korean War, far-sighted entrepreneurs started businesses such as Hyundai and Samsung, building significant empires from humble beginnings such as grocery shops. The visions of the founders of these companies are, by and large, the same; resurrect a prosperous Korea from the ashes of war. This vision ties the fate of the South Korean economy to the success of the businesses and is the key difference between conglomerates such as GE and the Chaebols. It is this difference that will truly impact on the sustainability of the Chaebol system.

The potential weakness in the Chaebol system is the family legacy – traditionally the management of the business is passed down from father to son. However, it seems that the management of the largest Chaebols are beginning to realise the potential risk involved with this strategy, and are beginning to recruit managers from outside the family and, in some cases, outside the country.

3.4 Conclusions

Sustainability has a broad definition in the modern world; to different people sustainability can mean industrial longevity or environmental conscientiousness. A major lesson from the company visits undertaken is that, in South Korea, industrial longevity is more widely understood. Businesses are chiefly concerned with growing their empires for the long term, and growing the Korean economy with them. Many of the South Korean Chaebols are still relatively young (Samsung is 43 years old) and were founded with the rather altruistic goal of building an economy for a country which had been devastated by years of occupation and war. Therefore, these companies feel a strong sense of responsibility to the health of the South Korean economy, and this

becomes central to their plans for the future. This responsibility is perhaps the major difference between the Chaebols and other conglomerates; all business decisions are taken in light of the huge responsibility they bear, which has the potential to improve their industrial longevity.

That is not to say that there are no companies placing emphasis on the environmental side of sustainability. Good examples are AmorePacific, who are committed to increasing their range of sustainable products by 10% each year, and POSCO, who have developed the Finex Ironmaking process. In fact, when questioned, most of the companies visited had some kind of environmental initiative in place. These initiatives tend to be driven by customers, whether these are end consumers or downstream businesses. Government regulation seems to play only a small part, and this is only where expected such as in the control of production emissions and efficiency of car engines. Many companies claim that they would like to place more emphasis on environmental issues, but are held back by a lack of financial viability.

In conclusion, the current meaning of sustainability in South Korea is dominated by industrial longevity. It is possible that increasing regulatory pressure from the government will begin to shift the focus to the environment, but this can only happen if environmental initiatives become financially viable. The growth of business in South Korea is inextricably tied to the recovery of a war-torn nation and, as such, industrial longevity will continue to be a major focus.

Case Study: S&T Holdings & S&T Motiv

S&T Holdings is the umbrella organisation for a group of companies specialising in the manufacture of precision parts in various industries. During the tour, four S&T companies were visited; S&T Motiv (automotive components, firearms), S&T Dynamics (powertrains, machine tools, castings, wind power), S&T Corporation (cooling systems) and S&T Motors (motorcycles, electric scooters).

The group utilises a high proportion of manual operation in the manufacture of its products, and does not appear to have any clear environmental policies in place, although a few of the companies have achieved ISO 14001 certification. However, all companies visited recognise the need for a sustainable future and S&T is committed to developing sustainable products and technology for its customers. These products include the developing of hybrid and electric engines for automobiles, air-cooled heat exchangers (rather than the traditional water cooled) and electric scooters. The willingness of S&T to develop such technologies before the market is fully ready highlights S&T's recognition of the importance of a sustainable future through technology. Furthermore, S&T have invested into the wind power industry, with commitment to global customers to develop and deliver highly efficient wind turbine powertrains.

S&T Motiv:

S&T Motiv is one of the two original businesses that form part of the holding company, S&T Group. After being a South Korean government firearms factory for approximately 8 years, S&T Motiv was privatised in December 1981 as Daewoo Precision Industries Co., Ltd. After a turbulent period through bankruptcy, a merger and a split, the company was finally acquired in 2006 to form what it is today. With its roots in firearms manufacture, the S&T Motiv has utilised its expertise in high precision technology to expand its portfolio of products to include automotive components, electronics and motors.

S&T Motiv has made extensive efforts to ensure its business sustainability. The move towards higher value added products, for example, has made it a leading automotive power-train manufacturer. Also, its electronics and motors divisions, it invests approximately 80% on R&D to anticipate future technology and follow industrial trends. For example, it has already developed the technology for electric vehicles, even though there is currently little market demand.

In terms of environmental sustainability, it has a strong belief that future demand will centre on greener technologies, thus has placed substantial focus on technologies such as electric vehicle components. Additionally, its sister company S&T Dynamics is developing the power-train needed for wind energy.

4 Innovation

Developing Asian countries are stereotyped for their ability to follow other nations into established markets, making use of externally developed technologies. In studying the sustainability of South Korea, the country's ability to innovate is of great interest, in order to assess whether it would benefit from developing into a first mover. Here we consider how South Korea could improve its innovation strategies by following the example of other countries; how the South Korean education system might influence the country's ability to innovate; and how current strategies are implemented.

4.1 Current Innovation Policy in Korea

The innovation system in South Korea has some noticeable strengths including: a highly educated labour force; large firms that are internationally competitive; the ability to adapt to be competitive in fast-moving markets and rapid technological change; and strong ICT infrastructure with high levels of mobile users.

According to Capgemini Consulting²², South Korea has been able to develop a sustained innovative economy through the following:

- Innovation through people and culture – strategic leadership, various participatory programs and accelerating the learning culture.
- Performance oriented changes – roadmap-based planning, improvement through measurement and performance management and incentive programs.
- Integrated innovation system – benchmarking from the private sector, problem solving and best practice diffusion and IT integrated Innovation systems.

As for investing in innovation, Korea has formulated 17 new growth engines and support for associated research; six projects in Green technology industries, six in state-of-the-art fusion industries, and five in high valued-added services. Korea is among the Top 3 spenders across Asia and has one of the highest levels of gross domestic expenditure on R&D in the world, with Korea's gross domestic expenditure on R&D accounting for 3.57 % of GDP in 2009, of which the government R&D budget accounted for up to 0.91 % of GDP.

²² <http://www.slideshare.net/koen.klokgieters/benchmarking-study-on-innovation-policy-29012010-3527737>

Case Study: Doosan Heavy Industries

Doosan Heavy Industries and Construction helped lay the foundations for Korea's economic growth. The company produces forged and cast materials required by industry as well as supplying power generation facilities, desalination plants and material handling systems to industry inside and outside the country.

Innovation has an important role to play within Doosan. Global climate change agreements have restricted the use of fossil fuels as a primary energy source in order to mitigate pollution and global warming. This has led to the development of the Molten Carbonate Fuel Cell (MCFC) for power generation which operate at high temperatures and are powered by gases from coal or natural gas. They have a higher efficiency than other fuel cell-based generators and discharge a lower level of pollutants. The Korean government, as a result, is pursuing the development of MCFCs as a national R&D project.

Doosan demonstrates its innovative capabilities through the development of proprietary technologies for a highly reliable MCFC power generation system to support the Korean government's energy drive.

A general weakness in basic sciences poses a fundamental problem, because scientific capability determines a nation's technological potential. As Korea has emphasized industrial technology development, scientific research has been more or less neglected; strengthening university research is vital to ensure the longevity of their technological future. In light of this, the government modified a five-year Comprehensive Regional Science and Technology Promotion Plan, which was set up in December 2007 at the end of the previous government, in Oct 2010. One of the four target areas is strengthening support for regionally-targeted R&D for regional economic growth with a particular focus on green growth R&D. Another target area concerns the enhancement of regional collaboration amongst industry, universities and research institutes.

Other government funded institutes include the Institute of Science and Technology, the Research Institute of Chemical Technologies, the Institute of Machineries and Metals, and the Electronic Technology Research Institute. These institutes emphasise the planning and conducting of national R&D projects to raise the level of scientific and technological skills. The Knowledge Sharing Program (KSP), a comprehensive policy consultation program launched by the Ministry of Strategy and Finance, has been established to share Korea's development experience with other countries.

4.2 Innovation Structures Globally

4.2.1 The United Kingdom

There are currently a number of Government initiatives within the UK looking to make it a more attractive place to create fast-growing businesses, and to create an environment for entrepreneurship. With Government investment there are trends towards an emergence of

clusters²³ with the benefits of networking, access to funding, elevated growth rates and a higher calibre of potential employees.

In its first three years the Technology Strategy Board (TSB), the UK's national innovation agency, has invested over £2 billion in UK innovation²⁴, along with external partners and businesses. The organisation will oversee a network of Technology and Innovation Centres based on the model proposed by Herman Hauser and James Dyson, for which the Government is expected to allocate £200 million over the next four years. The TSB has also identified priority areas into which it aims to focus investment and efforts over the next few years, to include Energy (£25m in-year expenditure anticipated 2014-2015), Built Environment (£10m expenditure), Transport (£20m expenditure), Food (£10m expenditure) and Healthcare (£25m expenditure).

In 2012 the Government is running a 'Business in You' campaign, looking at increasing the number of businesses starting up and growing in 2012. This includes a £200m program, 'GrowthAccelerator'²⁵, which is funded by the Department for Business Innovations and Skills and is aimed at helping 26,000 of England's most innovative businesses.

In terms of legislation, the Government has set up an independent review into intellectual property law in the UK, to ensure it fits with the move to growth and innovation, particularly for SMEs²⁶.

There are a large proportion of enterprises in the UK with some innovation-related expenditure, with the majority purchasing machinery and equipment in connection with innovation. Companies such as Rolls-Royce also have business partnerships with universities for access to the academic research base and graduate employees. The director of PwC's technology team, Brian Henderson²⁷, has said: "Technological talent within the UK is as strong as anywhere in the world, but it is the UK's potential lack of ability to successfully commercialise its technological breakthroughs that results in the market lagging behind that in other territories...".

²³ <http://techcrunch.com/2010/11/04/uk-government-plans-east-london-tech-cluster-startup-visa-review-of-ip-law-200-million-in-finance-what/>

²⁴ Page 12; Delivery Plan – Financial year 2011-2012; Technology Strategy Board

²⁵ www.inspiresme.co.uk/news/finance/-200-million-programme-delivers-growth-support-to-015333/

²⁶ www.inspiresme.co.uk/news/planning/patent-box-stays-intact-and-moves-a-step-nearer--s/

²⁷ www.inspiresme.co.uk/news/finance/is-vc-funding-for-uk-smes-dead--015039/

4.2.2 Germany

Innovation policy has always been high on the agenda in Germany, creating their reputation for industrial application of advanced technology.

One of the main innovation policy themes is access to funding. The funding of R&D by SMEs carries high risk and is therefore not popular in Germany's conservative markets. Therefore, the German government have created schemes including venture capital programmes such as the High-Tech Start-Up Fund, loan programmes and grant aid programmes. The Central Innovation Programme for SMEs (ZIM) which started in 2008 is currently the most important Federal Programme funding SMEs in R&D and innovation²⁸.

Germany's existing innovation tends to be in areas that show little growth potential for the future, such as Automotive, Machinery, Chemicals and Electrical Engineering. Therefore another important theme in the German Innovation Policy is to keep up to speed with emerging technologies, using 'Thematic R&D Programmes' focussing on seventeen priority fields of technology. These fields include biotechnology, nanotechnology, ICT, medical technologies, environmental technologies, space technologies and aircraft technologies, with nanotechnology and environmental technology receiving particular focus.

Germany is also home to the Fraunhofer Programme, Europe's largest application oriented research organisation²⁹. It consists of more than 80 research units, including 60 Fraunhofer Institutes in different locations around Germany. The organisation partakes in research into health, security, communication, education, mobility and the environment, amongst other technologies, with the aim of serving the general public. The research is contracted by private and public sector clients, and receives most of its funding this way (€1.5 billion). Some funding (€0.3 billion) comes from Federal and State Government grants.

²⁸Innovation and Innovation Policy in Germany, June 2012. <http://www.proinno-europe.eu/page/innovation-and-innovation-policy-germany>

²⁹ Fraunhofer, June 2012. <http://www.fraunhofer.de/>

4.2.3 The USA

The USA has been heralded as the home of innovation for many decades. The USA Government have a published Innovation Strategy, which details how the USA will 'out-innovate, out-educate and out-build' the rest of the world³⁰. There are three key points to the strategy:

1. 'Invest in the Building Blocks of American Innovation'
 - Improve the education system, particularly in the fields of science, technology, engineering and mathematics (STEM), by offering competitive grants for education centres, improving affordability of higher education by offering grants to students, and encouraging private-public partnerships to better prepare students for getting jobs upon leaving education.
 - Increase and strengthen scientific research in America, by increasing funding to key research entities including the National Science Foundation, the Department of Energy's Office of Science, and the National Institute of Standards and Technology laboratories. As well as these research foundations, there is also a Fraunhofer Institute in America (a subsidiary³¹ of Fraunhofer-Gesellschaft of Germany)³¹.
 - Develop a superior infrastructure including high speed rail and advanced air traffic control which will promote competition and innovation to maximise the return gained on infrastructure investments.
 - Develop an advanced information technology ecosystem, using high speed wireless internet access.

2. 'Promote Market Based Innovation'
 - Make the R&D tax credit given to small innovating business more transparent and permanent, creating a more inviting environment for entrepreneurship and innovation.
 - Promote entrepreneurship using the 'Start Up America' initiative³², aiming to enhance the profile of entrepreneurship amongst Americans and increase the number and scale of new high growth firms by increasing access to capital funding,

³⁰ The White House, Strategy for American Innovation: Executive Summary, June 2012.

<http://www.whitehouse.gov/innovation/strategy/executive-summary>

³¹ Fraunhofer USA, June 2012. <http://www.fraunhofer.org/AboutUs>

³² Fact Sheet: White House Launches Start Up America Initiative, June 2012.

<http://www.whitehouse.gov/startup-america-fact-sheet>

expanding entrepreneurship education and mentorship, strengthening the commercialisation of R&D and expanding collaborations between large companies and start-ups.

- Develop innovation ‘hubs’ to bring talented scientists and entrepreneurs together.
- Promote an open, innovative and competitive market by improving trade agreements with foreign countries and revising the guidelines for horizontal mergers.

3. ‘Catalyse Breakthroughs for National Priorities’

- Increase research into clean energy technologies, aiming to become a global leader.
- Accelerate biotechnology, advanced manufacturing and nanotechnology, in an effort to increase the availability of high class jobs in America, improve the drive for better health and promote industries that provide strong economic growth to America. The NIST Manufacturing Extension Partnership takes manufacturing advances from scientific research facilities and directs them straight to manufacturers, aiming to promote advanced manufacturing methods and ultimately increase the economic growth and number of jobs in the advanced manufacturing sector³³.
- Create innovations in health care delivery aimed at reducing cost, increasing efficacy and reducing errors through sharing more information to increase knowledge and understanding.

4.2.4 China

Within China, there are currently high levels of spending in R&D, science parks and research consortia. The current five-year plan calls for “indigenous innovation”³⁴, looking to transfer intellectual property to national champions and to subsidise strategic industries and sectors. Significant investment has been made in promoting entrepreneurship and growth within Hong Kong in particular. £1billion has been invested in a Hong Kong science park and an incubator, housing 600 start-ups, offering them free facilities and soft loans of around £500k.

China is now the third biggest spender in R&D, behind the US and Japan³⁵, but most of this goes into development and not research³⁶. However, R&D expenditure is not leading to an increase in new

³³ NIST Hollings Manufacturing Extension Partnership, June 2012. <http://www.nist.gov/mep/about.cfm>

³⁴ <http://www.economist.com/node/21549938>

³⁵ <http://www.forbes.com/2010/04/10/china-innovation-engineering-technology-notes-on-the-news-strategy.html>

³⁶ <http://www.economist.com/node/21549938>

patents. Taiwan manages five times as many per year, and Japan manages 30 times as many. China's intellectual property laws are sufficient on paper but poorly enforced. The focus on particular firms and industries also means that state-directed banks lend money to national champions at very low interest rates, starving smaller entrepreneurial firms of capital.

It is very difficult for new ideas to move from the laboratory to the market in China, but the country is a world leader at commercialisation³⁷ by testing products once out in the marketplace. There is more innovation here than there is in technical innovation, and the country is working to produce a higher number of graduates in science and technology in order to increase innovation levels across the board. In terms of other mechanisms, joint ventures between multinational companies also transfer technology to Chinese companies for access to the domestic market, and Chinese firms are increasingly looking to innovate with their supply partners.

4.3 Does the Structure of the Korean Economy affect how it Innovates?

There are various pros and cons associated with managing and encouraging innovation in companies of different sizes. Many of them are linked to the trade-off between the greater resources of larger companies and the greater agility of smaller companies.

With regards to their processes and systems, smaller companies usually rely on informal routes of communication that allow them to work quickly and adapt instantly to changes, but have few systems and low document or knowledge control. In contrast, a high level of information control is found in larger companies (although conversely the huge quantity of data they possess can negate any advantages conferred by often poorly implemented control systems) and they utilise formal, managed, regularly reviewed and usually slow-paced innovation processes.

The activities undertaken within each type of firm depend on this contrast between process and information management. Smaller companies often function through chaotic-but-heroic individual efforts, relying on unpredictable flashes of inspiration and initiative-based innovation, with larger companies utilising cross-functional teams, managed innovation tasks, and delegated authority structures.

The roles and expectations of individuals certainly play a key part in setting the rate of innovation within a firm. SMEs are often populated by flexible, innovative, self-sufficient, motivated workers, allowing basic innovation to thrive but often leaving parts of the whole process under-staffed.

³⁷ http://www.mckinseyquarterly.com/Three_snapshots_of_Chinese_innovation_2918

Case Study: Samsung Electronics

Samsung Electronics was founded in Suwon in 1969, and has grown to become the largest business division of the Samsung conglomerate. It dominates the world market in a number of different sectors, and is the world's largest producer of IT hardware, display devices (LCD and LED), and memory chips, as well as holding a prominent position in mobiles, digital appliances, telecommunications, digital cameras, and logic devices.

Samsung Electronics' revenue in 2011 was 165 trillion SKW, a 6.7% increase on 2010. However, their profits fell by 6.1% to 16.25 trillion SKW in 2011. Even so, the share price rose by 11% over the year.

Samsung Electronics admit themselves that they have become known more as a market follower than an outright innovator, using their extensive R&D resources to position themselves favourably in any profitable market. Their size and brand strength allows them to either out-compete or acquire many of their smaller rivals. However, they are taking steps to focus more on innovation, despite the strong position that their previous approach has established.

Samsung Electronics is a company that is relied upon heavily, both by the Korean economy (it makes up a staggering 14% of Korean GDP) and by the Samsung group as a whole, which gathers 70% of its revenues through the Electronics division. The Samsung conglomerate has recognised the risks involved with this situation, especially given the tight profit margins (and thus volatility) of certain crucial products such as mobile telephones. They plan to strengthen their position in other markets, including the medical and pharmaceutical industry, and this will both relieve some of the pressure on Samsung Electronics and possibly provide them with improved customer data and information.

Whereas larger companies tend to exhibit a managed balance between different employee types, and have an inherent culture that can inhibit the level of raw innovation but will ensure a more consistent implementation process.

The methods used to get information from the market can also be fairly opposite. Smaller companies often rely on intuition, insights, beliefs and surveys with small sample sizes, leading to an innovation process that is original but can suffer from a lack of focus or appropriate solutions. However larger companies use experience, market research, statistical sampling of customer needs and price sensitivity, giving excellent focus and understanding of customer needs and desires, but giving solutions that are constrained by preconceptions and over-familiarity with current solutions.

As for competition and IP, there is often limited competitor awareness and poor IP protection in smaller firms, leaving them vulnerable to attack from larger companies at the first signs of early success. The usually strong awareness of competitors and proficient legal capability found in larger companies allows them to instigate successful IP protection and maintain superiority over smaller companies through careful strategic dissemination of their IP protection, or even through the purchasing or licensing of technology.

In Korea, the importance of company size towards innovation is accentuated by the reliance on extensive R&D to generate new products. This reliance comes from a variety of factors:

- The lack of anti-monopoly laws has led to a business environment that is dominated by huge corporations (Chaebols) who are geared towards gaining market share through brand strength, resources, and R&D. They often lack the agility, or need, to out-compete smaller companies through the generation of new ideas.
- The strong scientific educational background of Korea,

which focuses heavily on knowledge-retention and learning by rote, leads to a workforce and culture that is geared towards R&D and places less emphasis on originality of innovation and blue-sky thinking.

- The nature of the markets in which Korea excels (the automotive and electronics markets being two major examples) is also geared heavily towards the ability to use extensive R&D to match competitors and maintain incremental innovation. This is suggested by the number of companies that plough resources into similar technologies, for example, 3D television.

In the face of this environment, small companies often struggle to punch above their weight using agile innovation; any small company that is seen to be successful runs the risk of either being bought by a larger rival (for example, Samsung electronics made 28 acquisitions during 2011³⁸) or out-competed by the mercilessly efficient market-following abilities of the conglomerates. These large companies rely on their superb R&D facilities to match rivals, and any new companies that do succeed are often backed by corporations and/or government support.

However, this situation is beginning to change. All of Korea's major political parties have announced that they will control the power of the Chaebols if elected to power, while large companies are showing signs of moving away from their market-following tactics due to the recent successes of some stand-alone technologies, such as LG Chemical's development of the Lithium-ion battery used in the Chevrolet Volt.

4.4 The Korean Education System

Education within South Korea is managed by the Ministry of Education, Science and Technology; straightaway this demonstrates the strong S&T (science and technology) focus driven by the understanding that an abundant pool of well-educated 'human resources' drives the success of R&D investments. Investing in education in advance, as Korea did in the 1960s and 1970s, was essential for laying a foundation for industrial development. Technological competence becomes critical as an economy develops; it requires high-calibre scientists and engineers who are capable of dealing with developments at scientific and technological frontiers. In Korea's case, education and industrialisation helped to sustain and accelerate this mutual development. Education made

³⁸ Page 46 -

http://www.samsung.com/us/aboutsamsung/ir/financialinformation/annualreport/downloads/2011/SECAR2011_Eng_Final.pdf

industrialisation possible via technological learning, which enhanced the rate of return on investment in education, further promoting its demand.³⁹

The competition for a place in a leading university begins in middle school for most South Korean students; the ultimate goal for most students is acceptance at one of the so-called 'SKY' schools: Seoul National, Korea or Yonsei universities. In South Korea's status-conscious society, a degree from a SKY school is nearly a guarantee of a big career and lifelong prosperity. Korean students spend about 16 hours each day memorising lessons and studying; it even reached a point where the Korean government had to take action by imposing a 10pm curfew on after-school programmes to try and ensure a healthier lifestyle.

The Korean education system is succeeding at producing highly qualified scientists and engineers to feed into the growing industries. However, as the role of their corporations is shifting from being market followers to market leaders and first-movers, the demands and expectations from a company's workforce are changing. The current educational system, dominated by repetitive learning formats and little originality, is suggested to produce adults who lack creativity and entrepreneurial skills⁴⁰. On visiting Samsung Electronics, it was described how the change to more global operations is putting stress on recruitment and often they must look overseas to find the necessary talent; the first non-Korean executive was employed last year to bring new creativity and more proactiveness to the board.

It is slowly starting to be understood that for Korean companies to be leaders in the global market, different mind-sets and approaches must be used. Home-grown innovation comes hand-in-hand with creativity and entrepreneurship; Korea is realising that current systems do not necessarily promote these qualities and it is falling to individual companies to rectify these shortfalls through global recruitment and non-traditional practices.

4.5 Conclusions

Korea has made enormous strides in science and technology over the past four decades. Through the continuous large investments in human resource development and R&D, Korea has succeeded in building a unique innovation system that is increasingly focused on home-grown technology. Yet there are problems too.

³⁹ <http://www.rrojasdatabank.info/wbdevecon10-22.pdf>

⁴⁰ <http://www.caviarcreme.com/korea-youth/956>

Firstly, although Korea spends a larger share of GDP on R&D than most other countries, R&D activities are highly concentrated in a small number of large enterprises, causing a serious imbalance in the system; the gap between Chaebols and SMEs is a real weakness in the current innovation system. Indeed, industrial R&D is skewed in favour of industries such as electronics. If this high concentration persists for long, it could potentially divide Korean industries into technologically advanced and retarded firms and sectors. In addition, this high concentration means that the R&D system is vulnerable to changes in economic and business environments. For instance, large Korean enterprises responded to the financial crisis of 1997 by cutting their R&D spending by about 14%, hurting the entire system.

Secondly, although Korea has reached nearly the same level as advanced countries in terms of science and technology inputs, it still has a long way to go in terms of R&D productivity. The most important source of inefficiency is the lack of interaction and exchanges among the major actors of innovation: universities, research institutes, and industry. Inter-sector mobility of scientists and engineers is extremely low and knowledge portals should be developed within the country itself before global links are encouraged in order to protect Korea's overall industrial health.

Government funding is directed at strengthening the basic scientific competency and expanding the strong technology knowledge-base throughout the country. It is clear by the level of investment that there is a firm understanding within government of the importance of innovation, and it can also be seen at a company level with larger risks being taken to increase competitiveness in the global market. For example; S&T Motiv, the only company manufacturing small calibre firearms in Korea as part of a large portfolio of other precision-technologies for the automotive industry, brought in a new CEO with little practical experience but a large amount of theoretical engineering management knowledge and global market expertise. This controversial move threw S&T's workforce into an uneasy state of change which has now proven successful by achieving double the output, with less than half the workforce and fewer hours, all within six years. Risk-taking, especially in the decisions of management, is fairly uncommon in Korea. However it is proving to be a necessity for the country to become market leaders in technology innovation.

5 Summary

The conclusions from each of the main sections of the report can be found below.

5.1 Manufacturing

Overall, manufacturing in Korea is in a healthy state and has weathered the recent crisis well. Its past growth and current scale are all primarily due to the macroeconomic policies of the past. The Korean economy is a prime example of a successful centrally-led, government directed economy. It breaks many of the rules and theories drawn up by Western free-market economists and runs contrary to the Washington consensus, which has driven Western ideology and policy for a generation. Protection was given to emerging industries to allow them to catch up with established competitors while efficiency was gained through export led growth and not through high levels of competition within the internal market. (This original reliance on imports actually resulted in the birth of the now mighty Korean ship building industry.)

The stability provided by this model was essential to generate the long period of rapid growth in manufacturing industrial sectors in the decades following the devastating Korean War. These protectionist policies of the past however are now being removed as Korea signs FTAs with nations around the world and both companies and countries turn to legal routes to ensure fair competition on a world stage. Business and politics are becoming more open with internal and external pressure to change. The established order of the Chaebol system is now seen as a headache from the past by many commentators and reform, for better or worse, will occur.

All of this, along with the other challenges faced by all manufacturers of sustainability and innovation; place Korea's manufacturing sectors at a critical point in it development. The old models for growth and acting as fast followers to catch up with industry leaders can no longer be followed at a time when many Korean companies are the industry leaders. Long term growth must now be achieved through innovation; with many companies that we saw expanding into the clean tech industries and developing more energy efficient and sustainable products.

Not everything is going to plan however: Korea's late push into the polysilicon and solar PV sector has faltered, with major investments and plants cancelled this year. The traditional big push from Chaebols and the government may no longer be sufficient to enable companies to enter new industries. Instead companies, such as Woongjin, have bucked this trend through process

innovation, allowing them to survive where others have failed. The national pride of the country has also been hit by the recent litigation between Samsung and Apple, with Apple overall coming out on top and any ruling against Samsung seen as a dishonouring of Korea itself.

Despite these setbacks, few question that Korea is likely to grow in importance as a global manufacturer, with its brands and products gaining greater market share and out competing others on cost, quality and innovation.

5.2 Sustainability

Sustainability has a broad definition in the modern world; to different people sustainability can mean industrial longevity or environmental conscientiousness. A major lesson from the company visits undertaken is that, in South Korea, industrial longevity is more widely understood. Businesses are chiefly concerned with growing their empires for the long term, and growing the Korean economy with them. Many of the South Korean Chaebols are still relatively young (Samsung is 43 years old) and were founded with the rather altruistic goal of building an economy for a country which had been devastated by years of occupation and war. Therefore, these companies feel a strong sense of responsibility to the health of the South Korean economy, and this becomes central to their plans for the future. This responsibility is perhaps the major difference between the Chaebols and other conglomerates; all business decisions are taken in light of the huge responsibility they bear, which has the potential to improve their industrial longevity.

That is not to say that there are no companies placing emphasis on the environmental side of sustainability. Good examples are AmorePacific, who are committed to increasing their range of sustainable products by 10% each year, and POSCO, who have developed the Finex Ironmaking process. In fact, when questioned, most of the companies visited had some kind of environmental initiative in place. These initiatives tend to be driven by customers, whether these are end consumers or downstream businesses. Government regulation seems to play only a small part, and this is only where expected such as in the control of production emissions and efficiency of car engines. Many companies claim that they would like to place more emphasis on environmental issues, but are held back by a lack of financial viability.

In conclusion, the current meaning of sustainability in South Korea is dominated by industrial longevity. It is possible that increasing regulatory pressure from the government will begin to shift the focus to the environment, but this can only happen if environmental initiatives become

financially viable. The growth of business in South Korea is inextricably tied to the recovery of a war-torn nation and, as such, industrial longevity will continue to be a major focus.

5.3 Innovation

Korea has made enormous strides in science and technology over the past four decades. Through the continuous large investments in human resource development and R&D, Korea has succeeded in building a unique innovation system that is increasingly focused on home-grown technology. Yet there are problems too.

Firstly, although Korea spends a larger share of GDP on R&D than most other countries, R&D activities are highly concentrated in a small number of large enterprises, causing a serious imbalance in the system; the gap between Chaebols and SMEs is a real weakness in the current innovation system. Indeed, industrial R&D is skewed in favour of industries such as electronics. If this high concentration persists for long, it could potentially divide Korean industries into technologically advanced and retarded firms and sectors. In addition, this high concentration means that the R&D system is vulnerable to changes in economic and business environments. For instance, large Korean enterprises responded to the financial crisis of 1997 by cutting their R&D spending by about 14%, hurting the entire system.

Secondly, although Korea has reached nearly the same level as advanced countries in terms of science and technology inputs, it still has a long way to go in terms of R&D productivity. The most important source of inefficiency is the lack of interaction and exchanges among the major actors of innovation: universities, research institutes, and industry. Inter-sector mobility of scientists and engineers is extremely low and knowledge portals should be developed within the country itself before global links are encouraged in order to protect Korea's overall industrial health.

Government funding is directed at strengthening the basic scientific competency and expanding the strong technology knowledge-base throughout the country. It is clear by the level of investment that there is a firm understanding within government of the importance of innovation, and it can also be seen at a company level with larger risks being taken to increase competitiveness in the global market. For example; S&T Motiv, the only company manufacturing small calibre firearms in Korea as part of a large portfolio of other precision-technologies for the automotive industry, brought in a new CEO with little practical experience but a large amount of theoretical engineering

management knowledge and global market expertise. This controversial move threw S&T's workforce into an uneasy state of change which has now proven successful by achieving double the output, with less than half the workforce and fewer hours, all within six years. Risk-taking, especially in the decisions of management, is fairly uncommon in Korea however it is proving to be a necessity for the country to become market leaders in technology innovation.

6 Overall Conclusions

Having considered South Korea from our three standpoints we can draw answers to the questions which we set out to address. The details of the answers can be found throughout this report, and some may draw inspiration from several visits or research areas.

What does it mean to be sustainable in the modern world?

It is clear that the Korean government has been significantly more involved in large scale environmental projects than the UK (such as the dream park⁴¹), but also that it recognises that it should not subsidise green energy for those who can afford to pay and should check that subsidies have been discussed, especially on Woongjin energy⁴². That environmental sustainability should not come at the expense of economic sustainability at either a government or business level. This is echoed within the majority of Korean businesses. Projects which save energy and protect the environment from harmful emissions are good, but because they provide a convincing business case by either reducing waste, avoiding costly clean-up programmes or improving brand image. The idea that it would be beneficial to embark on projects for the weakly defined concept of “eco-friendliness”, is neither common in Korea nor helpful. If businesses sacrifice competitiveness for the planet, they may help the environment in the short term, but in the long term a competitor who made the opposite choice will often prevail, nullifying their efforts in the long term.

Strong leadership is key in all large projects and perhaps the UK can learn from South Korea when dealing with large projects and deciding where to locate them. Drawing the example of the dream park project once more, the choice of site was opposed strongly by the residents of the area, but given the overwhelming case for the site to go ahead, the resistance was quashed. In the UK, many projects encounter the NIMBY problem (Not In My Back Yard), and this can stall key projects such as incinerators and landfill sites to the point of preventing their construction, even though the majority of the country believe the plan is a good one. If extra time and effort is spent making the project more attractive for residents (by adding additional benefits such as golf courses on the finished landfill), and not combing the country for a site where no-one will complain, much more would be achieved.

⁴¹ See case study, p34

⁴² Million Green Homes Project, p33

How should the UK and Korea position themselves in the future manufacturing landscape?

Korea appears to be carefully positioning itself as a supplier of not just high quality hardware, but also as a supplier of solutions which include substantial software components. This follows a global trend towards a greater and greater proportion of software in a wide range of products. However South Korea should be wary of trying to enter as a big player in the global software market without careful planning, several other nations such as India and Romania have already made a huge impact in this area and have a cost advantage.

From a sustainable industry perspective, many of the large conglomerates are trying to enter the green energy market. This is sensible given many of them have experience in electronics, traditional power generation and large scale fabrication. Although the national brand in this market is currently not very established, it is conceivable that they may begin to dominate this arena over the coming decades as the industry rapidly expands.

Korea has an additional driver to move to green power, in that it is a very mineral poor nation with relatively few natural resources. It relies heavily on imported fuels, and green energy which can reduce this dependency would greatly improve national security. Perhaps in the future, if reconciliation with North Korea can be achieved, then a unified Korea could take advantage of the more resource-rich mountains near the Chinese border. Reunification however will never be easy due to the now longstanding ideological differences between the two nations. Russia and China have in the past had interests in North Korea, which is one reason it has survived so long. Both have in recent times tried to distance themselves from the hermit kingdom, however foreign interests will always make the issue of North Korea even more complicated than it initially appears.

Where do ideas come from now, and what can we do to support innovation in the future to accelerate the pace of technological and economic growth?

One thing by which we have been struck is that the pace of technological growth within South Korea is already very fast, and further acceleration of the process is not necessarily an issue. In the past Korea has been known more as a fast follower than as a disruptive innovator but in some fields this is beginning to change. Firms are beginning to realise that in some areas they are becoming the trendsetters and that their management structures may need to change as a result.

Currently many of the large conglomerates have large private R&D facilities, much like traditional R&D in Europe. Many are also now moving to a more open model, or at least looking to bring in

external ideas, and several have successfully begun to lease out ideas they have developed. Samsung in particular is showing signs of beginning to grow via acquisition rather than just organically, which is a trend which has been seen in the west with very large businesses, however it is not clear whether this is part of a search for better technology or simply an exercise in empire building. Perhaps Korean firms could do more to act as suppliers of technology and information as they become technology leaders, as significant additional income could be made by licensing leading technologies internationally.

Some firms are looking to recruit internationally to fill skill gaps, which until recently would have been taboo as Korean firms have traditionally been very racially homogenous. Board level executives from the US and Europe have been brought into Korean firms to act as advisors, especially on software matters, showing commitment for not just graduate intake but also top level diversification of human resources.

7 APPENDICES

7.1 TATA Group Case Study

Tata Group began around 1868, as a cotton trading company in Mumbai founded by Jamsetji Nusserwanji Tata. Jamsetji Tata had the vision of doing three things: setting up an iron and steel company, generating hydroelectric power and creating an institution that would tutor Indians in the sciences. However, these were only achieved by Tata Group after Jamsetji Tata had passed away⁴³.

For most of the 20th century, Tata Group expanded into many different industries. Many of these were businesses founded within the group, such as Tata Chemicals (1939), Tata Motors and Tata Industries (both 1945), Voltas (1954), Tata Tea (1962), Tata Consultancy Services (1968) and Titan Industries (1984)¹.

Many of these were founded during the time when the Indian government had tight controls on businesses. Tata Group managed to experience high growth despite this. During this time, India had a poor capital market, and Tata Group had assumed the role of distributing resources.

Around the 1990's Tata Group started expanding to foreign countries, often acquiring major businesses in other countries. Among these are Tata Motors' acquisition of Jaguar Land Rover and NatSteel (now Tata Steel), and Tata Tea's acquisition of Tetley.

Today, Tata Group has 114 businesses in 8 sectors across 80 countries. It has remained successful by selling unprofitable businesses and improving the performance of others. Additionally, it has entered into foreign markets, thus diversifying its portfolio and reducing exposure to the Indian economy. It also attempts to instill a family culture within existing management, which is claimed to be a factor in its success. Despite this emphasis on the family feel, TATA actively searches for the best new CEO rather than appointing the closest relative as has been the case in the past and is still the case in many Korean Chaebols. This ensures that the group has competent leadership.

7.2 Mitsubishi Case Study

Yataro Iwasaki—the founder of the Japanese conglomerate Mitsubishi—was part of the Tosa Clan, a wealthy clan involved in international trade and shipping. The name of the original company was Tsukumo Shokai, and it was one of Japan's first trading companies founded in 1870. Tsukumo Shokai and later renamed Mitsubishi Shokai in 1873, following the government's abolishment of clan rule. It was one of the major shipping firms in Japan.

⁴³ <http://www.tata.com/htm/heritage/HeritageOption1.html>

Initially, most of the diversification was to fields loosely related to shipping—such as coal and copper mines, ship repair and warehousing. From 1890 onwards, they started to diversify into sectors such as glass, paper, steel, banking, insurance, real estate and trade.

In World War 2, Mitsubishi manufactured the primary naval fighter plane, including the planes used by the Kamikaze fighters. Japan fell into depression following its defeat in WW2. However, the founder's nephew took the helm of the company, and had a clear vision for commitment to quality and fair business practices—assisting manufacturers, producers and the public it served. This commitment and clear vision helped Mitsubishi outgrow its competitors.

Mitsubishi played a role in Japan's high growth between 1950-1960, creating businesses in newer industries such as petrochemicals, nuclear power, computers, and consumer goods and services. It experienced high growth and today Mitsubishi has over 500 companies in three categories or entities: Mitsubishi Bank, Mitsubishi Corporation and Mitsubishi Heavy Industries.

Mitsubishi attributes its success to a variety of factors. During the 1980-90s economic bubble, the company adopted a "slow and steady" approach, refraining from speculative trading and short-term profiteering. They have constantly expanded into new frontiers, from petrochemicals, weather forecasting and credit cards to, more recently, space exploration, through partnerships, acquisitions and organic growth. Perhaps most importantly, they had strong leadership and a clear vision during the tumultuous period following WW2.

The Gloucester Valley Battle Monument

While visiting the Gyeonggi-do Province around Seoul, the group took time to honour the memory of British soldiers who fought and died in the battle of the Imjin river in 1951 as part of the Korean war. For more information, go to: www.ifm.eng.cam.ac.uk/education/met/the-gloucester-valley-battle-monument/



Manufacturing Engineering Tripos

The Manufacturing Engineering Tripos (MET) is a unique two-year programme comprising the 3rd and 4th years of the Cambridge University engineering degree and based within the Institute for Manufacturing. Each year, final-year students undertake the MET Overseas Research Project (ORP) on a significant topic related to global manufacturing. Ten months of Cambridge-based research culminates in a two-week overseas study tour, visiting companies and other institutions in areas relevant to the project.

Institute for Manufacturing

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 grow and to become more competitive.

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