BRIDGING THE GAP BETWEEN R&D AND CONSTRUCTION INDUSTRY

Gue See Sew[1] & Chow Chee Meng[2]

ABSTRACT

The construction industry, which makes up approximately 2.7% or RM3.88 billion (3rd Quarter 2006) of our country's Gross Domestic Product (GDP – at current prices), and the multiplying effect it generates on other sectors such as manufacturing, transport, retail, hotel, real estate and restaurants, continues to play an important role in our economy. In fact, construction itself has played significant roles since ancient times where the level of civilization of a particular race or country was often measured by its engineering achievements in construction works. Notable construction works that come to mind include the Great Wall of China, Egypt's Pyramid of Giza, France's Eiffel Tower and Malaysia's Petronas Twin Towers. The construction of such structures was made possible with engineering advancements through Research & Development (R&D). In addition, in the face of globalization, R&D in construction plays a greater role in order to increase productivity and quality of works within a more stringent health, safety and environmental (HSE) environment, works specifications, deadlines and global competition. In this paper, some examples of the benefits of R&D to the construction industry are highlighted. It is hoped to demonstrate that R&D is not limited to the "bigger" players but can also be practiced by the so-called "smaller" players by adopting a conscientious effort towards promoting a healthy R&D culture within their organisations and work sites.

Keywords: Construction, Research & Development (R&D), Culture, Globalization

1. INTRODUCTION

In Thomas Friedman's best selling book entitled *The World is Flat: The Globalized World in the Twenty-First Century* (Friedman, 2006), he quoted the following African proverb which he observed written in Mandarin on a factory floor in China:

Every morning in Africa, a gazelle wakes up.
It knows it must run faster than the fastest lion or it will be killed.
Every morning a lion wakes up.
It knows it must outrun the slowest gazelle or it will starve to death.
It doesn't matter whether you are a lion or a gazelle.
When the sun comes up, you better start running.

In another example on how globalization affects the new knowledge economy, he quoted Jaithirth "Jerry" Rao of MphasiS, which is an Indian firm doing outsourced accounting work from any state in America and the US federal government:

[1] CEO/Group Managing Director, G&P Professionals Sdn Bhd, Kuala Lumpur, Malaysia
[2] Associate, G&P Geotechnics Sdn Bhd, Kuala Lumpur, Malaysia

Everyone has to focus on what exactly is their ***value-add****.*

The two quotes serve to emphasize the competition faced by the Malaysian construction industry as we compete globally with other international construction firms within our region and also other parts of the world. In addition, it is also anticipated that our local construction industry will be opened up to international competition in line with trade liberalisations. This illustrates the competition facing us, where we are like the gazelle that must run faster than the lion or end up being “swallowed” by globalization. And we must remember too that the lion has not stopped running either.

This brings us to the next quote where the keyword is value-added. According to Wikipedia, value-added refers to the contribution of the factors of production, i.e. land, labour, and capital goods, to raising the value of a product and corresponds to the incomes received by the owners of these factors. Value-adding is a must in the global economy as we must be able to carry out construction works with greater speed and efficiency while at the same time ensuring the works are of the highest quality.

Therefore, in order to survive in the lion-gazelle economy and to create value-add in order to compete globally and also attract foreign investment, research & development (R&D) is the key and our construction industry should embrace R&D and not view it as a taboo word reserved for scientists in white coats doing experiments with little relevance to actual practice. At the same time, researchers should not carry out R&D just for the sake of publishing and should aim for commercialisation of their products and also to add value to the industry, increasing efficiency and cost-effectiveness. R&D should be viewed as a means to improve our competitiveness in the face of changes that the whole world is currently experiencing and is further fuelled by the emergence of China and India as new economic powerhouses, the uncertainties with oil prices, threat of terrorism, etc. On this note, it is worthwhile to remember the following quote from David Schlesinger, Reuters Managing Editor:

Change is hard. ***Change is hardest on those caught by surprise.*** *Change is hardest on those who have difficulty changing too. But change is natural; change is not new; change is important.*

So, let us not be caught by surprise while our neighbours are making progress in the new globalised economy.

2. CURRENT STATUS OF R&D IN THE CONSTRUCTION INDUSTRY

Malaysia’s Gross Expenditure on R&D (GERD) recorded in 1996 was RM549.3 million and increased to RM2,843.7 million in 2004. This represents an increase in the ratio of GERD/GDP from 0.22 (1996) to 0.63 (2004). Even though GERD has improved, it must be noted and understood that Malaysia’s GERD in 2004 of RM 2.84 billion trailed far behind that of the United States at RM1.1 trillion, the EU15 at RM649.9 billion, Japan at RM459.2 billion, China at RM69 billion and Singapore at $4,062 million (approximately RM9 billion). This is illustrated in Figure 1 where Malaysia is positioned behind other countries such as Singapore, Brazil and India on research intensity in the year 2004 and is less than a third of the average for developed countries.

The current expenditure on R&D is also far behind our country's target of achieving a GERD/GDP ratio of 1.5% by 2010 based on the current progress. At the current rate, it is expected that we will only achieve GERD/GDP ratio of approximately 0.94% which is only 63% of the targeted 1.5%. Clearly, R&D efforts need to be intensified in order to ensure the targets can be achieved.

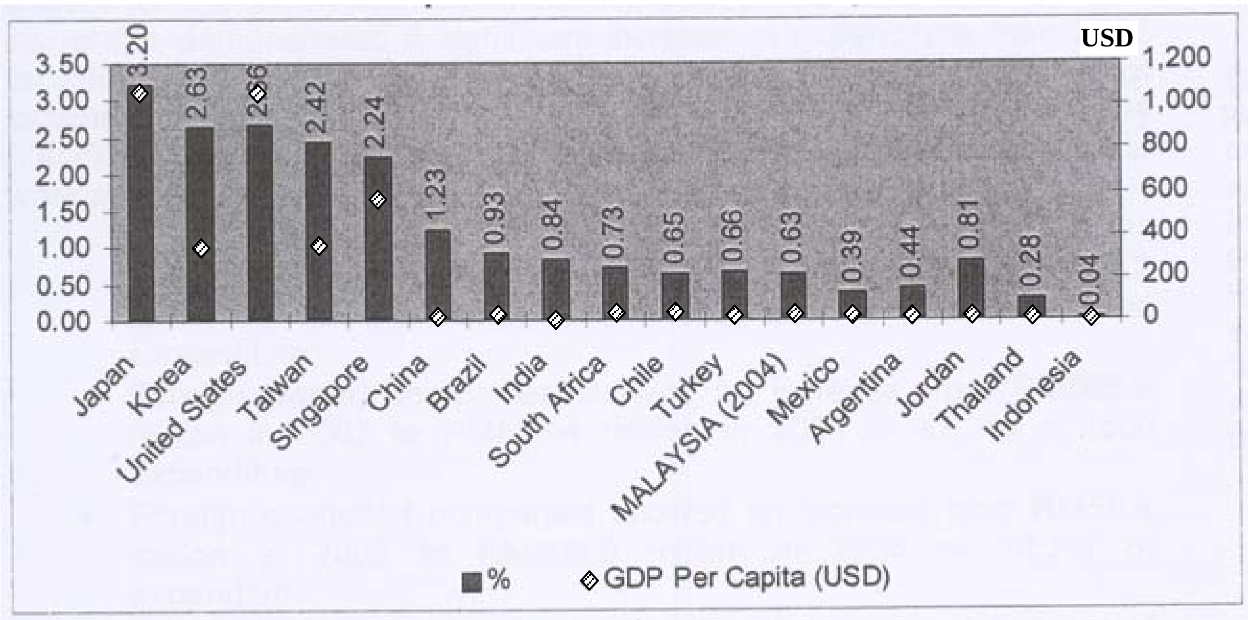

Figure 1: International Comparison of Research Intensity (after MASTIC, 2006)

As for the private sector's contribution to R&D from the year 2001-2002, it can be seen from Figure 2 that the contribution from the construction industry is negligible and this is not very encouraging and illustrates that more should be done to encourage private sector contributions to R&D.

Based on the statistics, it is evident that more allocations must be provided and concerted efforts from all parties are required in order to realise our target of achieving developed nation status by 2020. However, by having larger portions of the budget allocated for R&D alone is not enough. The allocated funds must also be properly utilised in order to derive the desired benefits. Currently, some R&D funds are still under-utilised by the public and private sectors. This is probably due to the lack of awareness of the availability of funds, the lack of awareness of the benefits of R&D and the lack of incentives and benefits for R&D works in the construction sector. This is illustrated in Table 1, where it can be seen that the private sector R&D personnel in the construction industry in the year 2004 only constitutes approximately 0.13% of the total private sector R&D personnel.

This is not surprising as a survey conducted by the Institution of Engineers, Malaysia (IEM) for the years 2000, 2002 and 2004 showed that the average salary of engineers in R&D was among the lowest among engineering employees. Such a situation certainly does not augur well for R&D activities in our country as the lack of incentives will not encourage the brightest people to be involved in R&D. The current situation will create a malicious cycle where research activities are not conducted by the brightest people and this will lead to a loss of faith in local research output and a brain drain to other countries such as United States, United Kingdom, Australia and Singapore. It was reported (MASTIC, 2004) that a total of 8100 Malaysian-born scientists and engineers were working in the US in 1999 while the numbers in Australia were 1,578 in 2001.

The current situation must be improved in order to realise our target of becoming a developed nation by 2020. We should also learn from the issues arising from our brain gain programme introduced in 1995 by getting key representatives from major stakeholders to review the programme in order to attract more scientists and technologists to our country, especially Malaysians who are currently working overseas.

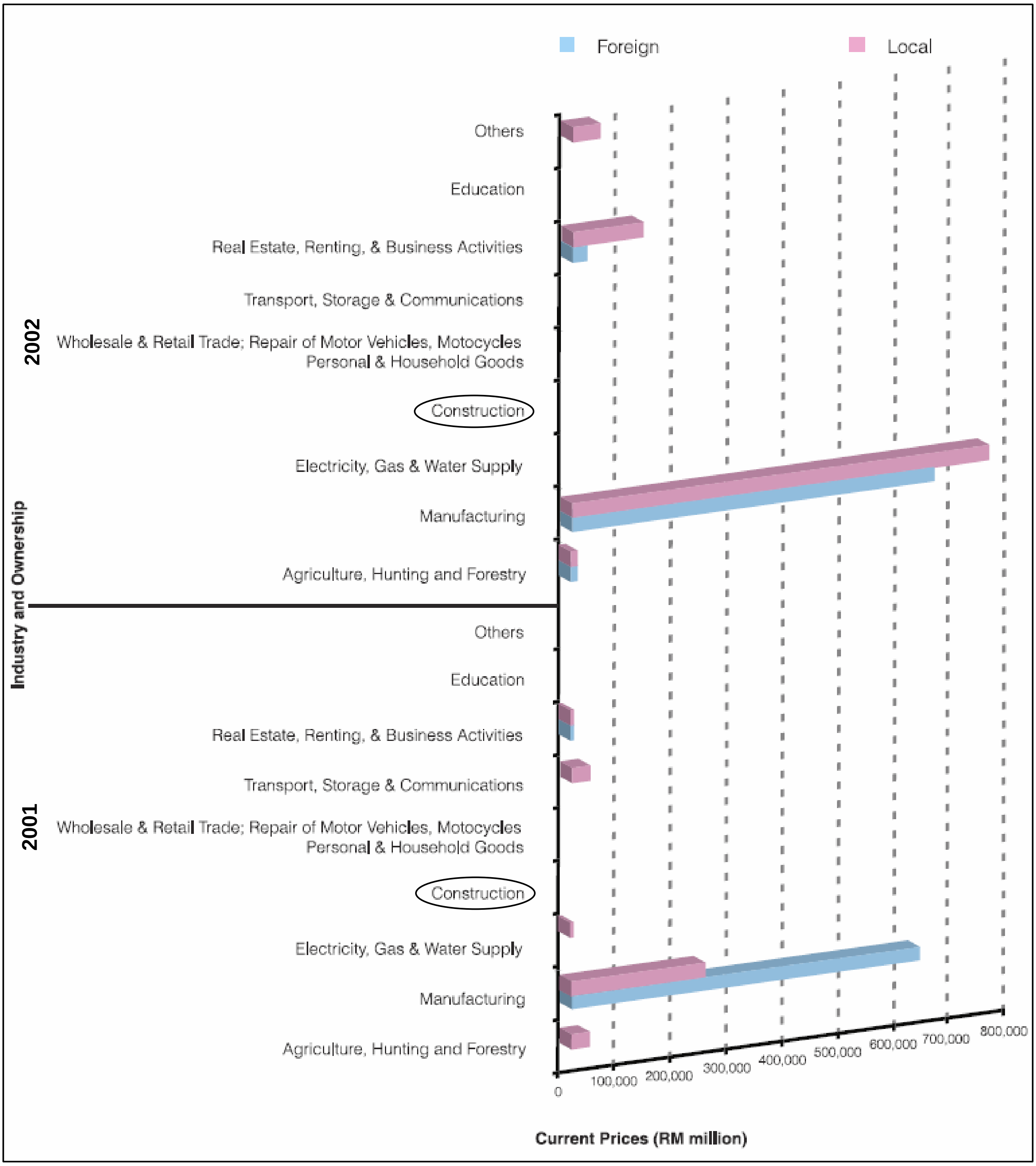

Figure 2: Private Sector R&D by Selected Industry and Ownership (Foreign & Local), 2001-2002 (after MASTIC, 2004)

Table 1: Private Sector R&D Personnel (Headcount) by Industry, 2004 (after MASTIC, 2006)

INDUSTRY	MALAYSIAN	FOREIGNER
Agriculture, Hunting & Forestry	1,156	53
Mining	370	6
Manufacturing	5,785	262
Construction	**11**	**-**
Wholesale & Retail Trade, Repairs of Motor Vehicles, Motorcycles, and Personnel & Household Goods	10	1
Transport, Post & Telecommunication, Activities of Travel Agencies etc	310	14
Real Estate, Renting & Computer Related Activities	285	33
R&D & Other Business Activities	282	4
Health & Social Work	69	4
Education	37	20
Public Administration & Defence, Social Security	11	1
Sewage & Refuse Disposal, Sanitation	3	1
Others	9	-
Total	8,338	399

3. BENEFITS OF R&D IN THE CONSTRUCTION INDUSTRY

Within a more stringent HSE environment, works specifications, deadlines, rising material costs and global competition, R&D can bring about benefits to the construction industry through:

a) Reduction in delivery time and construction costs which will lead to increases in profit margins
b) Increase in productivity and healthier and safer work environment for construction personnel (Better quality of life)
c) Environmental friendliness through reduction in energy consumption, wastages and pollution
d) Increased competitiveness in the face of global competition

The importance of HSE also merits special attention given the negative publicity surrounding the construction industry over the apparent low safety standards practiced in construction sites leading to loss of life (Figure 3). This further emphasises on the importance of R&D to increase productivity without compromising health and safety issues.

Figure 3: Loss of life due to construction accident at Sri Hartamas

While the benefits of R&D are usually difficult to be quantified directly in terms of profits, it is hoped to demonstrate in the subsequent sections that through R&D, the operational performance and profitability of a company will increase substantially such that any upfront investment in R&D will bring about many-fold returns on the investment.

4. R&D APPLICATIONS IN THE CONSTRUCTION INDUSTRY

R&D applications in the construction industry ranging from simple work improvements to the application of state-of-the-art technologies have been practiced and this has definitely improved the industry. Some examples are briefly discussed as follows:

a) Case 1: Evolution of concrete spacers
b) Case 2: Jack-in piles to replace driven piles
c) Case 3: Industrialised Building System (IBS)
d) Case 4: Innovative foundation design in soft ground
e) Case 5: Foamed concrete application at the SMART Tunnel
f) Case 6: Control of reclamation fill using RTK-GPS

<u>Case 1: Evolution of reinforcement spacers</u>

Simple innovations at the construction site with regard to a small construction element such as a spacer have led to better concrete quality, workmanship and increased productivity. This is made possible by adopting a healthy R&D culture in the work site. The use of spacers has evolved from the early use of stones (Figure 4) as crude spacers for concreting works to subsequent improvement works where simple reinforcement spacers are cast at-site in order to improve quality, workmanship and efficiency (Figure 5). Finally, in Figure 6, through further R&D works, further improvements have been made to spacers and this has certainly improved the quality of concreting works and reduces wastage.

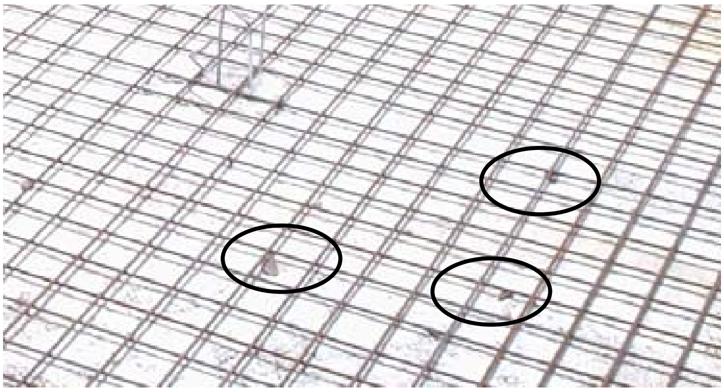

Figure 4: Early use of stones as reinforcement spacers

Figure 5: Cast at-site reinforcement spacers

Figure 6: Plastic reinforcement spacers

This case history serves to illustrate that R&D can be carried out from every aspect of the construction process and is not limited only to sophisticated research works involving state-of-the-art facilities. All that is required is a conscientious effort to improve the working procedures and a positive attitude in embracing change.

Case 2: Jack-in piles to replace driven piles

Conventional driven piles have been used extensively in Malaysia as a simple and robust deep foundation system. However, with increasing environmental constraints such as noise pollution and public complaints about excessive noise and vibrations, its current use is now limited to areas far from urban populations. The need for an economical foundation system within a more stringent environmental requirement has led to the development of the jack-in pile foundation system as an alternative to conventional driven piles. Currently, the use of the jack-in pile foundation system in Malaysia is gaining popularity and has even been adopted for high-rise buildings where pile sizes of up to 600mm diameter with a working capacity of 3000kN (jacked to 6000kN) have been adopted successfully. Figure 7 shows a typical hydraulic jack-in piling system used in Malaysia.

Figure 7: Typical hydraulic jack-in piling system used in Malaysia

In the near future, a more advanced jack-in/press-in system is expected to be used more extensively in Malaysia. The newer system is expected to eliminate the need for a heavy counterweight to derive the jacking force and therefore, offers advantages in areas with limited working space especially in congested urban areas. Figure 8 shows a typical press-in piling system using Japanese technologies.

Figure 8: Typical press-in piling system using Japanese technologies.

Case 3: Industrialised Building System

One of the challenges facing our construction industry is the acute shortage of construction workers. This, together with the social problems associated with foreign workers, further aggravates the situation. As such, through R&D initiatives, the Industrialised Building System is introduced to reduce our dependency on foreign workers.

The Industrialised Building Systems (IBS) is a construction process that utilises techniques, products, components, or building systems that involve prefabricated components and on-site installation. From the structural classification, there are five main groups of IBS being used in this country - Pre-cast Concrete Framing, Panel and Box Systems; Steel Formwork Systems; Steel Framing Systems; Prefabricated Timber Framing Systems and Block Work Systems (http://ww3.cidb.gov.my/information/publ/ibs-en.html).

The IBS system is more environmentally friendly compared to the conventional cast-in-situ method of construction. Various government initiatives have also been introduced to promote its application together with various other agencies such as the CIDB and research institutions such as the Housing Research Centre at UPM, etc. To-date, many successful structures have been constructed using the IBS system and typical examples are shown in Figure 9 for bridge construction.

Figure 9: Bridge construction using IBS system (http://www.eng.upm.edu.my/hrc/fotogaleri/BHS2004/visit/pic33v.jpg)

Even though the IBS system offers many advantages, its use in our country is still relatively modest and intensification in the use of the IBS system is much needed. Some of the limitations that need to be addressed (Thanoon et al., 2003) through further R&D work are as follows:

a) Cumbersome connections and jointing methods which are very sensitive to errors and sloppy work.
b) Despite an intensive marketing strategy since the 1980's in Malaysia to introduce modular coordination, its acceptance has received poor response from the building industry. As a result, even partial introduction of the IBS such as lintels, staircases, etc. has not been possible.
c) The industrialisation of the building process with emphasis on the repetitiveness and standardisation causes monotonous "barracklike" complexes that very often turn into dilapidated slums within several years. This shortcoming is further reinforced by production defects in building components which are quite frequent in the initial stages of prefabrication. Such defects, resulting from a lack of technical expertise and poor quality control, cause aesthetic and functional faults, such as cracks, blemishes, moisture penetration, and poor thermal insulation in completed buildings.
d) Prefabricated elements are considered inflexible with respect to changes which may be required over their life span.

Case 4: Innovative foundation design in soft ground (after Gue & Tan, 2005)

This case history highlights that R&D works can also be carried out within a consultancy practice which services the construction industry. In a housing development project of 1200 acres at Bukit Tinggi, Klang which is on very soft ground termed Klang Clay (Tan, et al. 2004), the Authors have designed an innovative foundation solution to solve this problem.

The innovative foundation uses short settlement reduction piles coupled with strip-raft foundations to support 2-storey to 5-storey buildings on soft ground. When designing the foundation system, short piles (the length of piles is a quarter to half of the depth to hard layer with SPT-N>50, depending on the load of the structures). This system can also be termed as settlement-reduction piled raft foundation and a similar compensated piled raft system has also been studied by Poulos (2006). Figure 10 shows the comparison of conventional piled-to-set foundation systems and the settlement-reduction piled raft foundation system while Figure 11 shows the completed 2-storey link houses with schematic of the foundation depth relative to the thickness of the soft compressible subsoil.

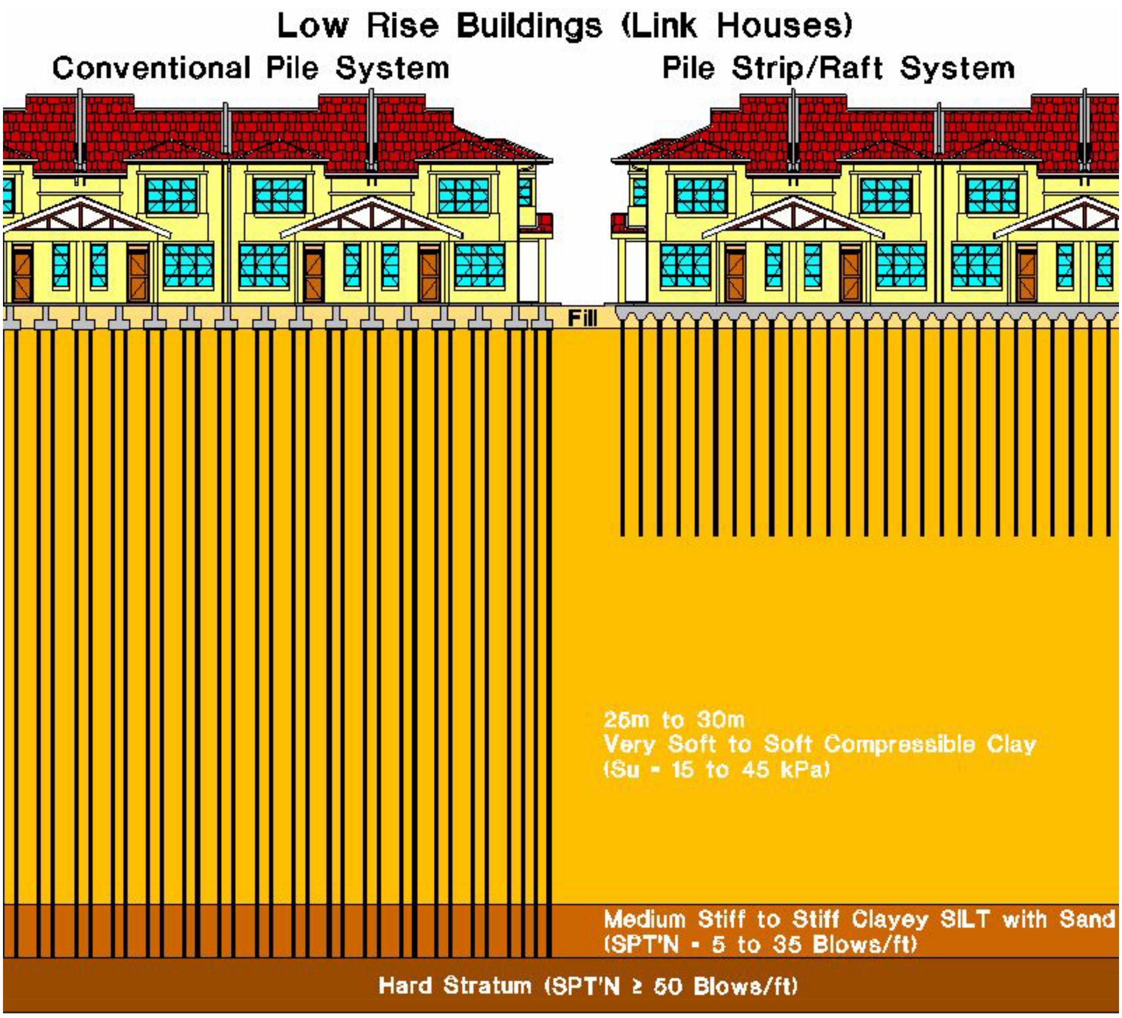

Figure 10: Comparison of conventional piled-to-set foundation systems and settlement-reduction piled raft foundation system (after Gue & Tan, 2005)

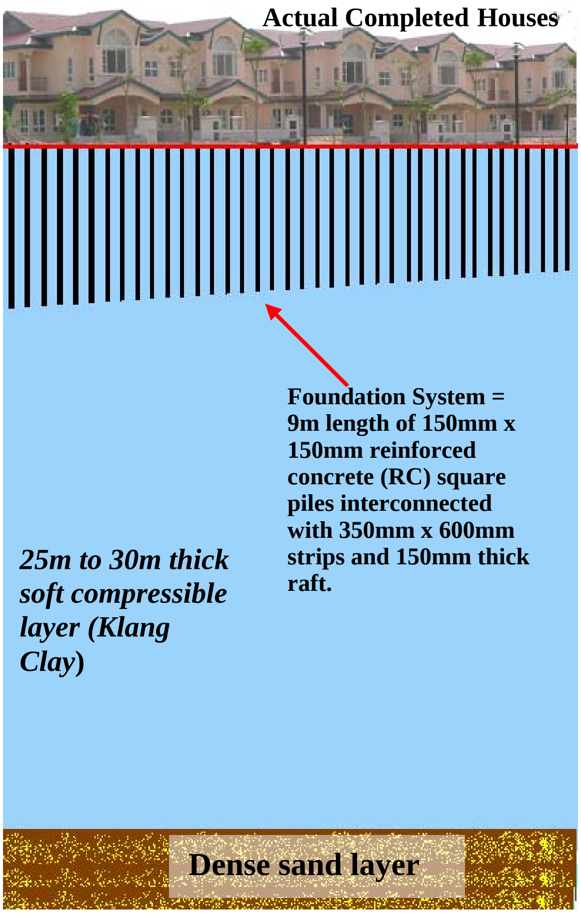

Figure 11: 2-storey link houses on settlement-reduction piles (after Gue & Tan, 2005)

The settlement-reduction pile foundation system is also extended to support 5-storey low cost apartments at the same site as shown in Figure 12 using variable pile lengths to control differential settlement to ensure minimum distortion.

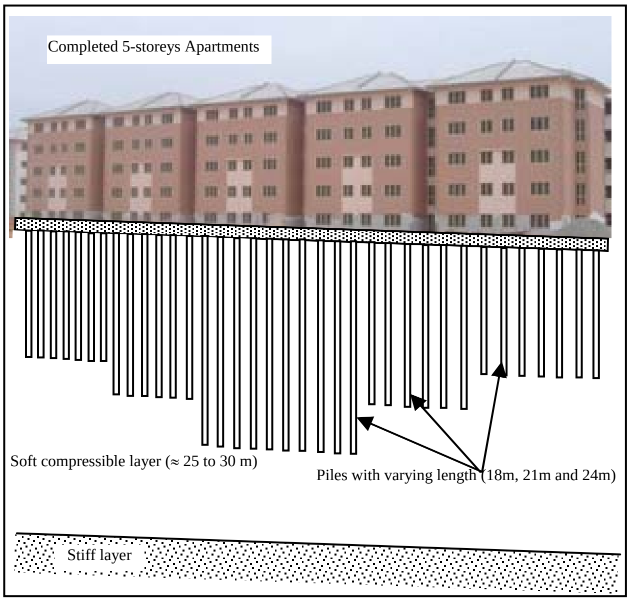

Figure 12: Schematic of piled raft system with varying pile lengths superimposed on completed low cost apartments (after Gue & Tan, 2005)

In this case history, the application of R&D and state-of-the-art design has resulted in substantial cost-savings in the foundation system while at the same time ensuring ease of construction. This has created value to the Developer, Contractor and also house owners.

Case 5: Stormwater Management and Road Tunnel (SMART)

In this case history, an innovative solution which is believed to be the first of its kind in the world has been designed to alleviate our city centre's flash flood and traffic congestion problems. The tunnel, which is approximately 9.7km in length, incorporates a novel design where a single tunnel serves the dual purposes of a stormwater tunnel and a road tunnel (Figure 13). The operation of the tunnel is divided into three modes as follows (MMC-Gamuda JV, 2005):

a) The first mode, under normal conditions where there is no storm or low rainfall, no flood water will be diverted into the system.
b) Under the second mode, the SMART system will be activated and this happens where there is a moderate storm. When the second mode is activated, flood water is diverted into the bypass tunnel in the lower channel of the motorway tunnel and it is important to note, that, at this stage, the motorway section is still open to traffic.
c) At the third mode of operation the motorway will be closed to traffic. With extensive and effective monitoring stations, when the third mode of operation is needed, the motorway will be closed to traffic. Sufficient time will be allocated to allow the last vehicle to exit the motorway before the automated water-tight gates are opened to allow flood water to pass through. The motorway will be reopened to traffic within 48 hours after the closure.

Figure 14 illustrates the 3 operation modes of SMART Tunnel. The tunnel is now nearing its completion and is expected to be open to the public in March 2007.

Figure 13: Cross-section of SMART Tunnel (www.smarttunnel.com.my)

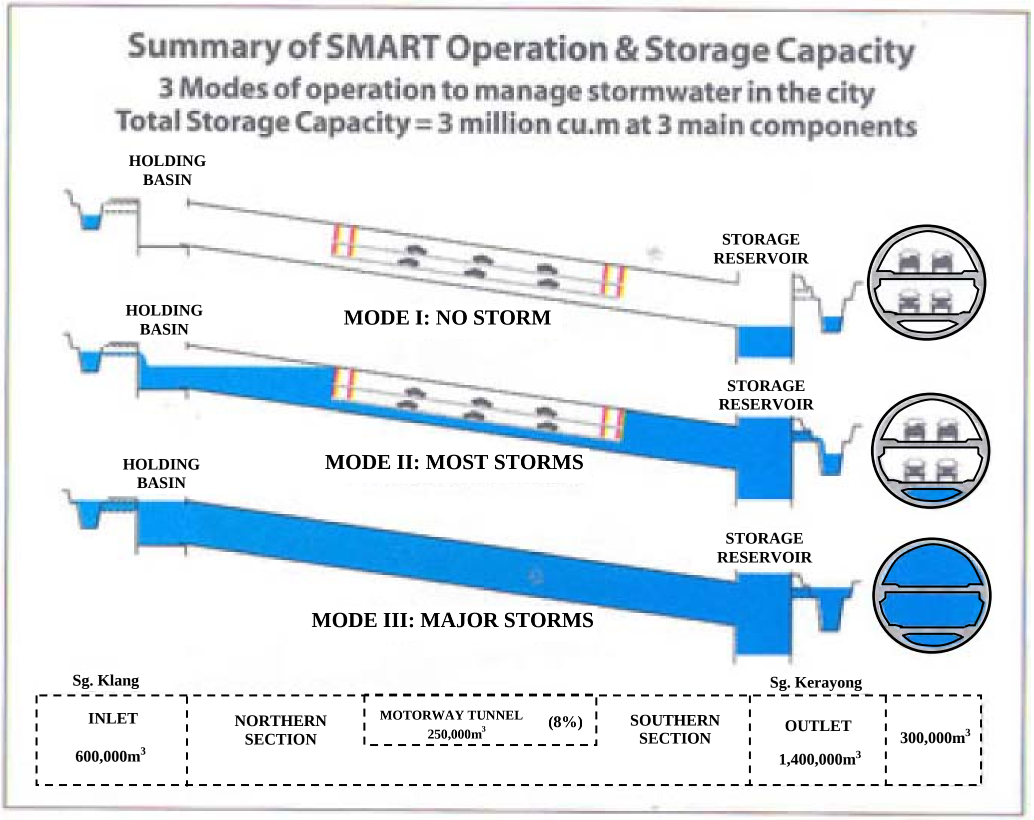

Figure 14: Operation Mode of SMART Tunnel (www.smarttunnel.com.my)

In addition, the SMART Tunnel project also initiated many R&D works to cater for its unique design and difficulties encountered during construction works carried out in the middle of Kuala Lumpur's busy city centre and through limestone formations. An example is the use of a special foamed concrete mixed using a proprietary foaming agent to protect the diaphragm wall when the tunneling machine is coming out into the junction box (Figure 15). The foamed concrete specified was of density 1800 kg/m^3 which achieved compressive strength of 3 N/mm^2 at the age of 28 days.

Figure 15: Foamed concrete application at the SMART tunnel in Kuala Lumpur (after Lee & Yung, 2005)

Case 6: Control of reclamation fill using RTK-GPS (after Furudoi, T., 2005)

For the second phase construction works at Kansai International Airport, where large scale reclamation works on soft deposits are carried out, the thickness of the sand blanket was carefully controlled by the latest technologies linked with RTK-GPS, such as accurate positioning of barges, real-time sounding and two dimensional bathymetric survey. In the reclamation works for the Kansai International Airport, newly developed "VS10" system is installed on all hopper barges for land reclamation operations in the second phase construction. The VS10 system manages all data including each barge's name, soil dumping position, soil dumping volume and soil source data, in a single database.

An accurate monitoring of gradual buildup of dumped soil was carried out by a narrow multi-beam echo sounder before and after dumping as shown in Figure 16. In the information database, shapes of the soil dumped from each hopper barges on the seabed of various depths were stored as well as results of pre-dumping bathymetric surveys. The database made it possible to estimate how the buildup of reclaimed land will take shape through preliminary dumping simulations (Figure 17). The suitable dumping location, the depth of water, the direction of the bow, etc. were determined based on the preliminary dumping simulations. The hopper barge was led to the designated dumping position by the navigation management support system called VS10 as mentioned above (Figure 18).

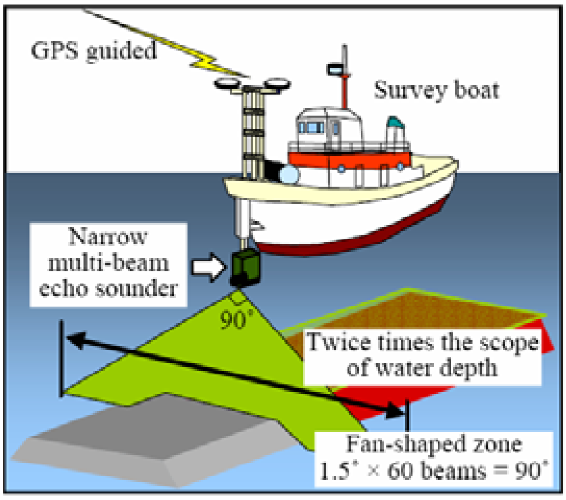

Figure 16: Conceptual scheme of bathymetric survey (after Furudoi, T., 2005)

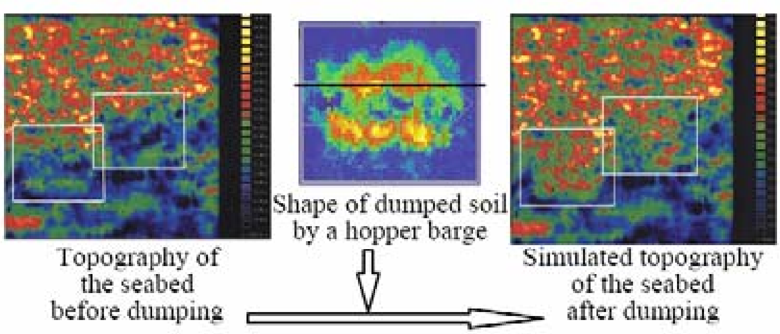

Figure 17: Preliminary dumping simulation (after Furudoi, T., 2005)

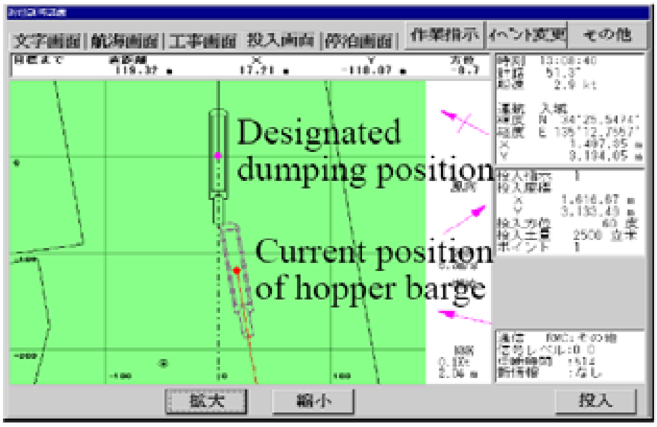

Figure 18: Navigation management support system (after Furudoi, T., 2005)

R&D applications in the construction industry should not be misunderstood as being limited to only physical processes of construction works as demonstrated in the Kansai International Airport case study. Other aspects of technology such as Information and Communication Technology (ICT), which will lead to smoother construction operations, logistics, etc., should also be encouraged and carried out as part of the R&D initiatives for the construction industry.

5. ROLES OF STAKEHOLDERS IN BRIDGING THE GAP

5.1 Public-Private Sector Linkages

The commercialisation rate of R&D projects in Malaysia is still modest, where it was reported (Hii Hnn-Hui, 2003) that only 5.1% of 5232 R&D projects implemented during the 7th and 8th Malaysian plan were considered commercialised. In addition, the commercialisation has not resulted in any significant licensing revenues for the universities and no R&D output from universities/institutes has been commercialised yet on a national scale. While, it is believed that some improvements must have been made since then, but in comparison, we are still lagging far behind other developed countries. For example, the University of Strathclyde, UK alone generated more than £42 million in royalty income from its research activities over the years (www.strath.ac.uk/research).

The statistics clearly show the existing weakness between public-private sector linkages where the commercialisation rate is very low. The public sector must realise the importance and the relevancy of research output such that R&D activities are geared towards practical applications while the private sector should make use of the research facilities available in research institutions to enhance their R&D capabilities. For example, in Australia, a high proportion of economic gain from R&D is derived from firms that undertake most of their R&D in-house, but also maintain associations with public sector research institutions (Jones, 2001).

Therefore, private companies should form strategic alliances with research institutions to provide input to the institutions' R&D activities while research institutions should actively seek partners from the private sector to ensure the relevancy of its R&D

activities. Universities should also maintain a strong relationship with the industry through its alumni, appointment of adjunct professors from industry, etc.

5.2 Government Incentives

The government has provided various schemes to support R&D activities in order to achieve the target of becoming one of the world's industrialised economies by 2020. Some of the schemes introduced by the government since 2002 are as follows (MASTIC, 2004):

a) Technology Acquisition Fund for Women (TAF-W)
b) E-Manufacturing Grant
c) Grant for RosettaNet Standard Implementation for SMEs
d) Grant for Upgrading Engineering Design Capabilities
e) Technology Acquisition Fund (TAF)
f) Commercialisation of R&D Fund (CRDF)
g) Double Deduction for Income Tax Purposes
h) Industrial Technical Assistance Fund (ITAF 2)
i) Demonstrator Application Grant Scheme (DAGS)
j) Multimedia Super Corridor (MSC) Research and Development Grant Scheme (MGS)
k) Industry R&D Grant Scheme (IGS)
l) Intensification of Research in Priority Areas (IRPA) Program

From the above list, the relevant schemes which are applicable to the construction industry are:

a) Technology Acquisition Fund (TAF)

   The Technology Acquisition Fund (TAF) is a scheme administered by the Malaysian Technology Development Corporation (MTDC), a joint venture company between the Government and the private sector. Its main objective is to facilitate the acquisition of strategic technologies by the industrial sector.

b) Commercialisation of R&D Fund (CRDF)

   CRDF provides an impetus towards the commercialisation of R&D activities, in particular for public sector R&D activities that have commercial potential. The major objectives of CRDF are to enhance the competitiveness and capacity of the Malaysian industrial sector by promoting the commercialisation of indigenous technology and to accelerate commercialisation of R&D efforts by local universities and research institutions, companies and individual researchers or inventors.

c) Double Deduction for Income Tax Purposes

   Double deduction on revenue expenses incurred in research and development as an incentive for carrying out R&D activities has been introduced by the government and it has been a popular scheme among industries such as the automotive and food industries, etc.

d) Industry R&D Grant Scheme (IGS)

The IGS was established by the then Ministry of Science, Technology and the Environment (now known as the Ministry of Science, Technology and Innovations) with the intention of encouraging the private industries in Malaysia to be more active in research and development so as to be better equipped to compete globally.

e) Intensification of Research in Priority Areas (IRPA) Program

IRPA is a major effort by the Ministry of Science, Technology and Innovation to encourage research and development activities, particularly in the national R&D priority areas, in the public sector. R&D activities in areas with the potential for enhancing the national socio-economic position of the nation are given funding support. In addition, this scheme is also aimed at enhancing R&D linkages between the public and private sectors. Although the scheme emphasises activities that will lead to commercialisation, some funding allocation is also given to research activities directed towards knowledge advancement as a long-term measure for building capacity towards the development of the K-economy. The parties eligible to apply for funding under the IRPA program are public research institutions and universities.

With the various funding schemes introduced by the government to support R&D initiatives, it was expected that the R&D expenditure would increase consequently. However, this is not the case as illustrated in the approval of grants for IGS in Figure 19 where a declining trend is observed.

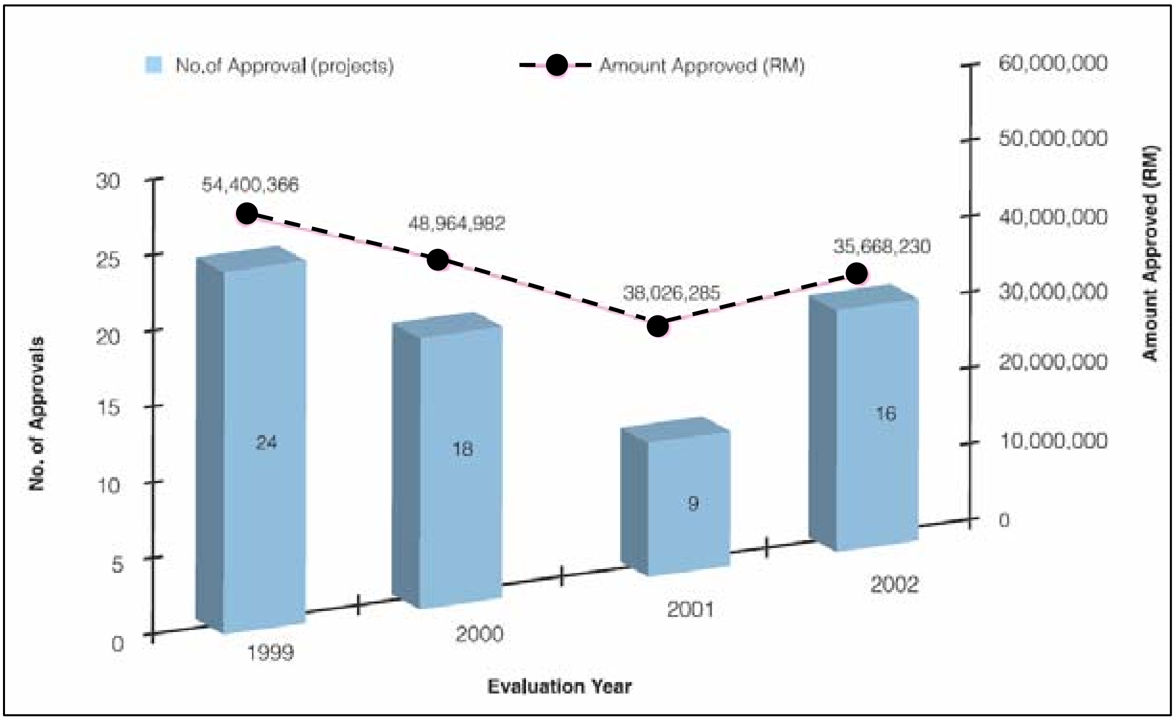

Figure 19: Approvals of Grants under the Industry R&D Grant Scheme (IGS), 1999-2002 (after MASTIC, 2004)

The under-utilisation of the funds indicates there is significant room for improvement especially in public-private sector cooperation. This requires a different approach towards R&D cooperation between research institutions such as universities and the private sector. A change in mindset is necessary such that either party will not wait for the other "to court" them. Some of the reasons often cited for the low level of cooperation between the public and private sectors are the lack of interest from the private sector and bureaucracy in public sectors which does not encourage cooperation. It is high-time that our research institutions adopt a different approach towards R&D cooperation where they will play a more proactive role to demonstrate the benefits of R&D to the industry while at the same time the private sector should view R&D with an open-mind.

The relevant institutions responsible for disbursement of the R&D funds also need to address the following issues (MASTIC, 2006) to ensure the successful implementation of the R&D initiatives:

a) Procedures for the application of these incentives are not clear
b) Information requested in the application for some of these incentives are company secrets
c) The scope of eligibility of some of these incentives are too narrow
d) The definition of R&D for these incentives is not clear

Other measures to further boost R&D includes:

a) Quality researchers should be recruited especially those with a post-graduate degree
b) Researchers should be rewarded accordingly especially those with findings that are successfully commercialised
c) Applications for research funds or grants should be evaluated and recommendation made within 3 months

5.3 Developing a Culture of Excellence

In order to improve the construction industry's competitiveness and to prepare ourselves for globalisation, it is important that the industry adopts a culture of excellence to compete globally. Developing a culture of excellence requires strong commitment from the top management of an organisation. As proposed by Jim Collins (2001) in the book *Good to Great*, a successful organisation consists of:

a) A Level 5 leader who exhibits the strongest professional will
b) Getting the right people for the right job
c) A system to confront brutal facts and the ability to act on it
d) A deep understanding on the nature of the business
e) Culture of discipline
f) Innovative use of technologies

The author has studied 1500 companies in the US and only 11 companies passed the criteria to be classified as a "Good to Great" company. The minimum criteria to be a "Good to Great" company are sustainable tremendous growth for more than 15 years and consistently outperforming the same types of companies within the same industry.

From the studies, it was concluded that companies which exhibit the above organisational traits ultimately create a conducive working environment which is likened to a flywheel where the momentum created by disciplined action ultimately leads to sustainable and spectacular profits.

It is worth pointing out that companies which follow the philosophy of “Good to Great” will naturally have a system of managing information (ability to confront brutal facts and to act on them), a deeper understanding of the business and innovative use of technology, which is essentially R&D in the general sense. As such, R&D should be a part of any organisation intending to be “Good to Great”.

In summary, some simple steps which an organisation can take in order to promote a culture of excellence include:

a) A strong understanding of the nature of its business by a having a clear company vision, mission and objective. The top management must be committed in realising the company’s vision, mission and objective; otherwise, it will only remain as mere statements.
b) A system for sharing of knowledge, e.g. via intranet or internet.
c) A healthy feedback from all levels of the organisation, e.g. dissemination of information through internal technical colloquiums, brainstorming between management and staff, etc.
d) Company policy of promoting innovation and creativity.
e) Allocate certain percentage of time for R&D works (e.g. 10-20% of working hours or 4-8 hours in a week). The R&D works should be geared towards improving the organisation such as improvement of work processes, construction costs, health & safety, environmental considerations, etc. via a system of feedback where a “wish list” is compiled with regards to improvements that can be made to organisations. The R&D activities should also be monitored and coordinated by an R&D committee to ensure its effective implementation.
f) R&D incentives and reward schemes. For example, an annual R&D Achievement Award in the form of cash incentives to be given to the best R&D product developed internally within an organisation which adds value and is used by the company.

5.4 Roles of Stakeholders

Different stakeholders within the construction industry, such as universities, government agencies, contractors, consultants and manufacturers should also play their respective roles in order to develop the construction industry via R&D.

In this respect, it is worth quoting two examples from the book *The World is Flat* (Friedman, 2006) and *The Blue Ocean Strategy* (Kim & Mauborgne, 2005) on the importance of R&D culture within an organisation which leads to great success:

<u>Case 1: Wal-Mart</u>

Wal-Mart today is the biggest retail company in the world and it is worth noting that Wal-Mart does not make a single thing. What it has is a hyperefficient supply chain which moves 2.3 billion general merchandise cartons a year down its supply chain into its stores.

And how did Wal-Mart evolve from a small company from northwest Arkansas to the biggest retailer in the world? It is through R&D and the use of latest technologies to increase its efficiency and profit.

One of the key lessons learnt from the Wal-Mart success story is the sharing of information, which is a key component in order to make R&D work. Wal-Mart realized that while it had to be a tough bargainer with its manufacturers on price, at the same time it also realized that it is beneficial to both parties if they can collaborate to create value for each other. Wal-Mart was one of the first companies to introduce computers to track store sales and inventory and was the first to develop a computerized network in order to share this information with suppliers. Wal-Mart's theory was that the more information everyone had about what customers were pulling off the shelves, the more efficient Wal-Mart's buying would be, the quicker its suppliers could adapt to changing market demand.

According to Rena Granofsky, a senior partner at J.C. Williams Group Ltd., a Toronto-based retail consulting firm: "Opening its sales and inventory databases to suppliers is what made Wal-Mart the powerhouse it is today. While its competition guarded sales information, Wal-Mart approached its suppliers as if they were partners, not adversaries".

"By implementing a collaborative planning, forecasting, and replenishment (CPFR) program, Wal-Mart began a just-in-time inventory program that reduced costs for both the retailer and its suppliers. Thanks to the efficiency of its supply chain alone, Wal-Mart's cost of goods is estimated to be 5 to 10 percent less than that of most of its competitors".

The example of Wal-Mart may not be directly related to the construction industry but nevertheless, it serves to illustrate the benefits of sharing of information, which is part of R&D. Similar sharing of information will also be beneficial to the construction industry where information on market demand, availability of raw materials, construction machinery, research findings, etc. can be shared between different stakeholders in an efficient manner to improve the efficiency of the construction industry delivery system. This can be done through a central agency such as CIDB which will compile, maintain and disseminate such information to all its members. The system, however, can only work through close cooperation of all parties involved.

Case 2: Samsung Electronics

Samsung Electronics realised the importance of innovation in its business by establishing the Value Innovation Program (VIP) Center in 1998. Core cross-functional team members of its various business units come together in the VIP Center to discuss their strategic projects. In 2003, the center completed more than eighty strategic projects and opened more than ten VIP branches to meet business units' rising demands. For example, the world's leading forty-inch LCD TV, launched in December 2002, is the result of one project team's devoted four-month efforts at the center. So is the world's best-selling mobile phone, the SGH T-100, which has sold more than ten million units.

Since 1999, Samsung Electronics has established an annual Value Innovation corporate conference presided over by all of its top executives. At this conference, Samsung's hit Value Innovation projects are shared through presentations and exhibitions, and awards are given to the best cases. This is one way that Samsung Electronics establishes a common language system, instilling a corporate culture and strategic norms that encourage innovation through R&D or according to the Blue Ocean Strategy's authors (Kim & Mauborgne, 2005); lead its corporate business portfolio from red to blue oceans.

In Samsung's case, it can be seen that a healthy R&D culture is encouraged within the organisation which leads to its business success. The introduction of the VIP Center encourages creativity and innovation and demonstrates the willingness of its management to allocate resources for R&D for long-term advancement of the company. While the book *The Blue Ocean Strategy* essentially focuses on creation of uncontested market space and making the competition irrelevant, it is important to realise that it is only possible if the company has the foresight and commitment to innovate its business through R&D which will eventually leads to significantly better profit as compared to the conventional red ocean of existing market space. This is demonstrated in Figure 20 where it can be seen that for 86% of the new business launches in the conventional red ocean of existing market space studied by the authors, it accounts for only 62% of total revenues and a mere 39% of profits. The remaining 14 percent of the launches were aimed at creating blue oceans. They generated 38% of total revenues and 61% of total profits. In summary, R&D increases profitability.

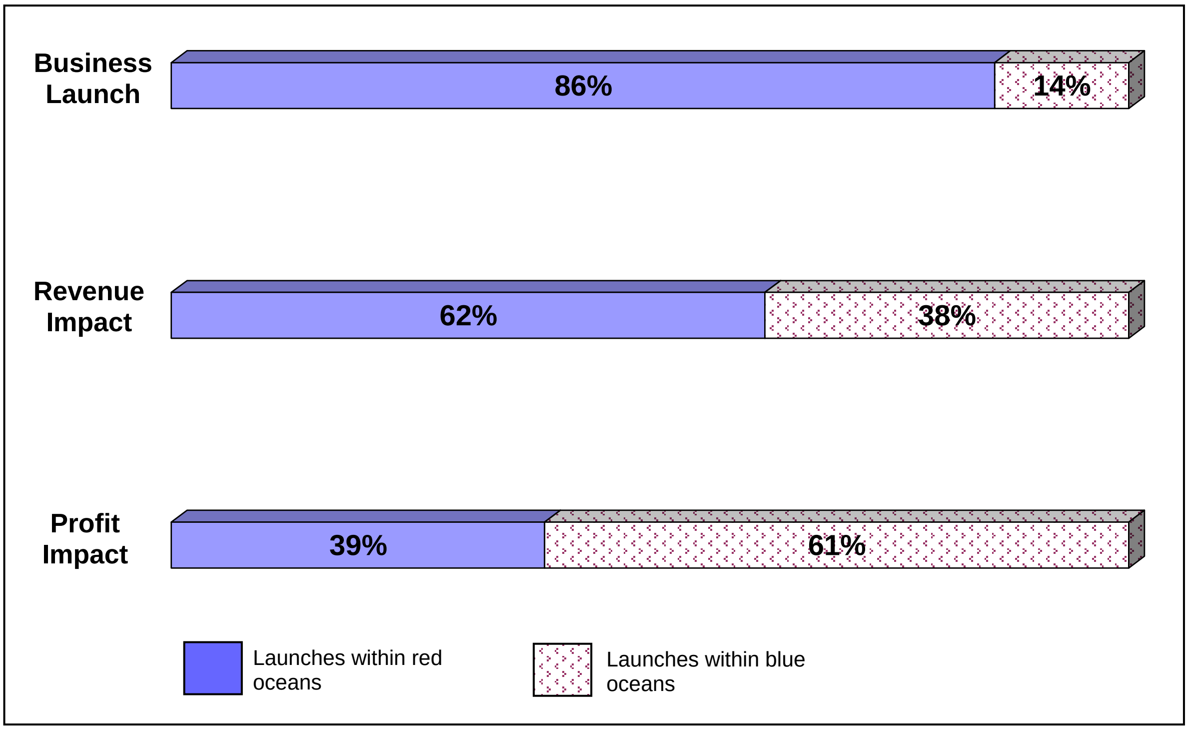

Figure 20: The Profit and Growth Consequences of Creating Blue Oceans (after Kim & Mauborgne, 2005)

5.5 Roles of CIDB in Promoting R&D in the Construction Industry

The Construction Industry Development Board (CIDB), formed with the objective of developing the Malaysian construction industry towards globalization and to develop the construction industry to produce quality construction products in line with value spent and responsive towards the nation's needs, is well positioned to act as the facilitator towards a healthy R&D culture within the construction industry.

The roles that can be played by CIDB to promote R&D include:

a) A centre for the accumulation and dissemination of information related to the construction industry. In this respect, a construction information portal can be developed and maintained by CIDB to enhance cooperation between different parties within the construction industry.
b) To identify R&D needs for the construction industry by compiling "wish lists" from different stakeholders.
c) Coordination and monitoring the use of allocated R&D funds for the construction industry.
d) Coordinator/moderator between public and private sector to enhance cooperation
e) Coordinator/moderator for cross industry cooperation, e.g. applications of ICT, innovative financing methods, etc.
f) Link between the government and the private sector
g) Coordinator/moderator in international projects such that effective transfer of technologies can be realised via joint ventures, partnerships, etc.

From the previous discussions, it is evident that various measures are already in place to promote R&D in our country. What is lacking is the implementation and the lukewarm response from the industry. As such, CIDB can play the role of catalyst for the successful application of R&D in the construction industry by monitoring the use of R&D funds, encouraging private and public cooperation and implementation of other incentives to promote R&D.

In order to fulfil its function to develop the construction industry and to further encourage R&D in the construction industry, CIDB can take the lead by allocating a fixed percentage of its financial resources and income for R&D.

6. CONCLUSION

The Malaysian construction industry is facing greater challenges in the face of globalisation. The need to increase productivity and quality of works within a more stringent health, safety and environmental (HSE) environment, works specifications and deadlines is ever growing. As such, it is important that the construction industry embraces Research & Development (R&D) as a means to improve its competitiveness, efficiencies and profits. It is demonstrated that R&D activities are not restricted to state-of-the-art research works carried out in high-tech facilities. Simple R&D efforts will also yield significant benefits to any organisation. Adopting a culture of excellence with emphasis on continual improvements through R&D is important to create a conducive working environment for R&D activities to supplement the various initiatives introduced by the government to enhance R&D output.

A change of mindset in both the public and private sector on their views on R&D cooperation is also required to create synergy between the two sectors and enhance our country's economic competitiveness. In this respect, CIDB is well-positioned to play the role of catalyst to encourage cooperation between public and private sector in R&D activities, to monitor the R&D output and to inculcate a culture of excellence within the construction industry in order to realise its objective of developing the construction industry towards globalisation.

REFERENCES

Collins, J. 2001. Good to Great: *Why Some Companies Make the Leap….and Others Don't*. HarperCollins, New York, USA.

Friedman, T. L. 2006. *The World is Flat: The Globalized World in the Twenty-First Century (updated and expanded)*. Penguin Books, London, England.

Furudoi, T. 2005. Second phase construction project of Kansai International Airport – Large-scale reclamation works on soft deposits. *Proc. 16th ICSMGE*: 313-322, Osaka, Japan.

Gue, S.S. & Tan, Y.C. 2005. Innovative Substructures on Soft Ground. *Master Builders Journal (2nd Quarter)*: 8-14.

Hii, H.H. 2003. *Diagnosis and Prescriptions of National Innovation System: Case of Malaysia* (Powerpoint Presentation). Website: www.it-lodge.com.

Kim, W.C. & Mauborgne, R. 2005. *Blue Ocean Strategy: How to Create Uncontested Market Space and Make the Competition Irrelevant*. Harvard Business School Press, Boston, Massachusetts.

Lee, Y.L. & Hung, Y.T. 2005. Exploitation of Solid Wastes in Foamed Concrete – Challenges Ahead. *Proceedings of International Concrete Congress*: 15-22, University of Dundee.

Malaysian Science and Technology Information Centre (MASTIC), Ministry of Science, Technology and Innovation. 2004. *Malaysian Science and Technology Indicators: 2004 Report*.

Malaysian Science and Technology Information Centre (MASTIC), Ministry of Science, Technology and Innovation. 2006. *Malaysian Science and Technology Indicators: Draft Final Report*.

MMC-Gamuda JV's Website. 2005. *www.smarttunnel.com.my*.

Poulos, H.G. 2006. The Application of Piled Raft Foundation Systems to Soft Clay Sites. *ISSMGE ATC-7 Workshop (Invited Lecture)*, 17th November 2006, Korea.

Tan, Y.C., Gue, S.S., Ng, H.B. & Lee, P.T. 2004. Some Geotechnical Properties of Klang Clay. *Proc. of Malaysian Geotechnical Conference 2004*: 179-186, Selangor.

Thanoon, W.A., Lee, W.P., Mohd Razali Abdul Kadir, Mohd Saleh Jaafar & Mohd Sapuan Salit 2003. The Essential Characteristics of Industrialised Building System. *International Conference on Industrialised Building Systems*: 283-291, Kuala Lumpur, Malaysia.