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Industrial R&D Expenditure: Its Determinants and Propensity of Technology Transfer of Top Ten Companies in Malaysia, Singapore and Taiwan[1]

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Abstract Global research and development (R&D) spending has increased in recent years as the need for new technologies has grown and structural changes in the market have become evident. R&D and its transfer into the commercial sector have an important relationship. This paper analyzes the relationship between industrial R&D expenditure and how it affects technology transfer in Malaysia, Singapore and Taiwan. The research is based on the analysis of secondary data from published annual reports followed by a quantitative analysis of primary data using survey questionnaires. The research finds that the bulk of R&D expenditure was from the top ten organizations and the top five industries for each country. The findings also reveal that an organization's readiness in terms of technology and people capabilities is still weak in Malaysia and Singapore. The findings also indicate that there is a relationship between industrial R&D expenditure and the propensity of technology transfer in Taiwan.

Keywords R&D expenditure, technology transfer

I. Introduction

Global research and development (R&D) spending has increased to a total of US$ 1.6 trillion in 2013 as the need for new technologies increases and there is growth in competition (Batelle, 2013). Technology is a critical element for the development of a nation's economy and has been recognized as an important catalyst for corporate success (Millman, 2001). According to the Global

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Competitiveness Report 2016-2017, which assessed the competiveness landscape of 148 economies and provides insight into the drivers of a country's productivity and prosperity, Singapore was 2nd, Taiwan was 15th and Malaysia was 18th (Schwab and Salai-Martin, 2017). R&D is one of the competiveness drivers. It is the primary source for technology development and it is becoming ever more critical due to technology trajectory, short product lifecycle and globalization (Park and Lee, 2011). R&D has been widely accepted as a driver for socioeconomic development in a country and is increasingly perceived as being the root of sustainable economic growth and competitive advantage (Griliches, 1979; Arundel and Geuna, 2004; Guellec and Pottelsberge, 2004; Becker and Pain, 2008; Hedge and Hicks, 2008; Laforet, 2008). R&D also motivates the creation of innovations which leads to new products and processes that either increase an organization's revenue or reduces its costs, and it is regarded as the fundamental driver of technological progress and endogenous growth. It also increases productivity through process improvement (Mairesse and Sassenou, 1991; Hall and Mairesse, 1995; Guellec and Pottelsberge, 2003; 2004) and profitability through cost reduction (Perry and Grinaker, 1994; Qiu and Tao, 1998). As competition becomes more intense, organizations are forced to search for growth opportunities to move ahead of their competitors through R&D spending. Research has also demonstrated that increasing R&D spending, through the optimal allocation of resources, is critical for improving technological competitiveness, advancing an organizations' growth and achieving sustainable development (Hall, 1993; Lev and Sougiannis, 1996; Cheng and Chen, 2006).

However, R&D must be supplemented by a sustainable technology transfer strategy, which is the process of transferring technology, together with the necessary technical skills and knowledge (Walter, 2000). Technologies can be innovative, visionary, ground-breaking and disruptive, but the ability to transfer the technology can be far more difficult than conducting R&D activities themselves (Zhouying, 2005). There are cases where there is no growth in the organization after investing in R&D. For example, Scherer (1983) discovered that the impact of R&D on productivity was insignificant due to the organization's inability to transfer the R&D outcomes. Therefore, a successful R&D activity must be followed by an effective technology transfer activity, so that the outcomes will not stagnate at the development stage. Effective technology transfer will lead to successful commercialization where organizations are able to improve manufacturing productivity, alliance efficiency and adaptability, international expansion and sustainable competitive advantage (Cui et al., 2006).

This study intends to close the gaps identified above by identifying and describing the determinants of industrial R&D expenditure from the top ten R&D spending publicly-listed companies. We compare the relation between

industrial R&D expenditure and its propensity of technology transfer across three countries as a comparison between a developing (Malaysia) and two developed countries (Singapore and Taiwan).

II. Literature Review and Conceptual Foundation

Past studies have delineated key determinants of high industrial R&D expenditure, namely, company size, availability of internal R&D funding, past profits or earnings, annual sales growth, availability of R&D staff, subsidies from government for companies to undertake R&D, and market share and competition. The determinants are discussed in detail in section 2.1. Our hypothesis posits that there is a relation between industrial R&D expenditure and the propensity of technology transfer in the top ten R&D spending publicly listed companies in Malaysia, Singapore and Taiwan.

1. R&D Expenditure and Its Determinants

There is a substantial amount of theoretical and empirical literature exploring R&D expenditure and their determinants (Nadiri, 1979; Waterson and Lopez, 1983; Bhagat and Welch, 1995; Becker and Pain, 2008; Lee and Hwang, 2003; Griffiths and Webster, 2004). Many organizations limit R&D expenditure because the return is always uncertain and the high maintenance costs, such as the wages of scientists and researchers, testing facilities, laboratories and other intangible costs are difficult to estimate. Therefore, investing in R&D activities requires long-term planning and the acceptance of a certain level of risk. Company size is one of the best documented factors that affect R&D expenditure. The study by Cho et al. (1999) on Korea's IT industry and the study by Grabowski and Vernon (2000) on eleven major US drug firms indicated that company size correlated with the size of R&D expenditure. In addition, the US National Science Board (2008) report shows that large companies invest more in R&D and dominate R&D activities.

However, Coad and Rao (2010) argue that R&D expenditure is negatively correlated with company size and found that R&D expenditure increases proportionally with company size when above a certain threshold level. Thus, this study focuses on large companies, i.e. publicly listed companies, to analyze their R&D expenditure.

The availability of funds to support R&D expenditure largely depends on an organization's internal capital, as the risk and uncertainty of R&D returns make it difficult to raise external capital. Bond, Harhoff and Reenen (2003)

conducted a study of 263 British and 246 German organizations from 1985-1994. The results indicated that, while there were significant constraints in the UK economy, there are no such limitations on German organizations. However, the findings can be explained by the different financial systems in the UK and Germany (Bond, Harhoff and Reenen, 2003). Another study of 500 large manufacturing organizations in France and the US (1982-1993) indicated that cash flow appears to have a positive relationship with R&D expenditure, but this had a much higher impact in the US compared to France (Mulkay, Bronwyn and Mairesse, 2000). In addition, studies of the US pharmaceutical industry showed that cash flow has a significant effect on R&D expenditure (Malmberg, 2008).

Past profits or earnings have also been found to impact on the amount of R&D expenditure by a company (Reynard, 1979; Mulkay, Bronwyn and Mairesse, 2000; Chambers, Jennings and Thompson, 2001). The growth of profit increases an organization's capacity to provide internal R&D funding. Therefore an increase in profit means that an organization is able to invest more in R&D. In contrast, organizations with high debt will be more cautious in making R&D investments. In Reynard's (1979) study of 25 chemical organizations, the results showed that downward profit trends statistically correlate with a decrease in R&D expenditure. A study by Griffiths and Webster (2010) also indicated that past profits had a significant impact on current R&D investment. Other researchers have argued that previous earning is not always a factor, especially for those organizations with intensive R&D activities, such as bio-pharmaceutical organizations (Barth, Kasznik and McNichols, 2001).

Sales growth is another determinant of R&D expenditure. An increase in sales can be related to R&D expenditure as R&D results in higher productivity due to the spillover mechanism (Coe and Helpman, 1995). Morbey (1988) found that there was a positive relationship between R&D expenditure and the sales performance of many US organizations. Another study of the pharmaceutical industry showed that R&D expenditure is closely related with the gross margin (Scherer, 2001). A study of 152 Korean listed organizations by Kim and Lee (1993) also suggests that sales growth strongly affects current R&D expenditures. Based on empirical studies, the optimum R&D expenditure is believed to be affected by the proportion of net profit to sales.

Human capital within an organization also contributes to R&D expenditure. Research has shown that there is robust evidence showing that human capital-related matters such as wages and R&D staffing also affects R&D expenditure (Patrik and Andreas 2003; Wu, Li and Liu 2003). Wu, Li and Liu (2003) found that there is a positive relation between the ratio of R&D staff and R&D intensity, which in turn, influences the industry framework. It is essential for a firm to hire, and retain, high quality scientists and engineers to conduct R&D

activities in a highly competitive market. The presence of talented scientists or engineers who can effectively communicate ideas and results improves an organization's R&D performance (Kermani and Bonacossa, 2003). However, attracting qualified and skilled personnel is a challenge.

Another determinant is subsidies from governments, which include R&D tax credits and direct subsidy policy tools to encourage R&D activities. Hall and Reenen (2000) concluded from their study that tax credits positively affect an organization's R&D expenditure. Government intervention and public investment in R&D activities help minimize the organization's cost for R&D. An empirical study by Griliches (1979, 1998) indicated that R&D expenditure would be higher than expected especially for smaller organizations if there were no significant external financial constraints such as the government limiting funds. However, the results are ambivalent as there may also be a negative effect since the hazard and burden of a result-sharing agreement due to the subsidy may be taken as a disincentive to conduct R&D activities (Lee and Hwang, 2003).

Market share and competition is another important determinant for R&D expenditure. Empirical studies indicate that the higher the organization's market share, the greater the increase in R&D expenditure (Raji, Gary and Shrihari, 2011). The influence from R&D expenditure may resemble intangible capital stocks, barriers to entry for other organizations or market demand factors which help increase the organization's market share (Bae and Noh, 2001). Competition, especially in product markets, indicated that domestic organizations will be aggressive in their R&D expenditure in order to counter competition from others (Spencer and Brander, 1983).

2. Technology Transfer

Technology transfer has been defined in many ways by various researchers (Souder, Nashar and Padmanathan, 1990; Phillips, 2002; Burhanuddin et al., 2009; Liu, Li and Xue, 2010; Mamat and Roslan, 2012). Technology transfer in this study is defined as the movement of know-how, technical knowledge, systems or technology from one setting to another and involves physical equipment or materials, or as research-related to production (Roessner, 1993; Abdul Wahab, Che Rose and Osman, 2012). Technology transfer is commonly acknowledged as a challenging and complex process even when it happens across different functions within a single product division of a single organization (Zaltman, Dundan and Holbeck, 1973; Smith and Alexander, 1988). It is one of the most important aspects in the management of technology since it resembles a commercialization process of R&D activities in a tangible or intangible form which focuses on improving an organization's competitiveness or by creating a competitive advantage (Ramanathan, 2001).

Practicing effective technology transfer enables an organization to improve its productivity, improve its efficiency and adaptability, enable international expansion and maintain a competitive advantage (Cui et al., 2006). There are various mechanisms classified according to the different aspects of technology transfer. Two of the major mechanisms are vertical and horizontal transfer (Mansfield, 1975; Cohen, 2004). Vertical transfer refers to the transfer of technology along the continuum from the more general to the more specific. It transfers basic research to applied research, development and production respectively which this research is concerned with (Osman-Gani, 1999). Horizontal transfer occurs through the adaption of technology from one application to another or the movement of technology from one place to another e.g. the adaptation of military aircraft to civilian air transport (Cohen, 2004).

There are some deficiencies and limitations in technology transfer. This is mainly because the organization and transfer mechanism fail to apply a sufficient *client needs* approach (Seaton and Cordey-Hayes, 1993; Kumar and Jain, 2002). Among the deficiencies are failures to adequately recognize the significance of the transferee's needs, which leads to a failure in addressing the service delivery aspects of the technology transfer. Another deficiency is underestimating the importance of the interactive processes and mechanisms such as the continuous relationship between the transferor and transferee where real benefit accrues to the transferee. Finally, a failure to understand the contribution of technology towards a competitive advantage or towards effectiveness is yet another deficiency, possibly caused by technology transfer failing to generate opportunities and instead posing threats to the organization.

To overcome these limitations, it is essential to enhance the effectiveness of technology transfer. According to Abdul Wahab, Che Rose and Osman (2012), it is possible to take different approaches or strategies to achieve effective technology transfer. Toregas et al. (2004) stress that the service to clients, recruiting talented people, the use of capabilities to augment staff and leadership commitment are four important elements for effective technology transfer. According to Burhanuddin et al. (2009), technology transfer is only deemed successful or fully transferred when it is commercialized into a product that is sold in the market or utilized in process improvement activities.

III. Methodology

Secondary data analysis and a survey are carried out in this study. The secondary data is mainly collected from the annual reports of Public Limited Companies (PLC), these being downloaded from the companies' websites or Bursa Malaysia. The total amount of R&D expenditure spend in 2011 and 2012 is analyzed. We also analyze the R&D expenditure of the top five

industries from each country. Those organizations which were involved in more than one business activity were categorized under the industry most relevant to its R&D activities or based on the source of primary revenue of the organization.

We also conduct a quantitative study where primary data is collected and analyzed. The approach used is descriptive research and is concerned with the relationship between variables (Churchill and Lacobucci, 2010) and it reduces the risk of social desirability bias associated with self-administration (Biemer and Lyberg, 2003). The primary data is collected through the distribution of questionnaires to the top ten organizations with the highest R&D expenditure, identified from the secondary data (see Appendix 1 for the list of top ten organizations). Purposive sampling is used as the top ten organizations total R&D expenditure are more than 50% of the overall R&D expenditure in the country, which ensures that the sample size will be sufficiently representative of the entire population and the comparison samples have similar characteristics.

Relation strategy, which has three possible results, positive relation, negative relation and no relation (Christensen, Johnson and Turner, 2011) is used to analyze the relation between industrial R&D expenditure with the propensity of technology transfer. In general, R&D expenditure should produce positive impacts on the technology transfer process. However, due to the small sample size, such that the findings cannot be generalized, hence the hypothesis which is based on yes or no relation strategies has been devised for verification in the study. The hypothesis for this study is that there is a relation between an organization's R&D expenditure and its propensity of technology transfer in Malaysia, Singapore, and Taiwan.

IV. Analysis and Results

In this section, the R&D expenditure of public listed companies (PLC) in the three countries (Malaysia, Singapore and Taiwan) is analyzed. The data for the R&D expenditure was extracted from companies' annual reports, official websites or the country's stock exchange. This is followed by the analysis of the primary data from the questionnaire.

1. Secondary Data Findings

The secondary data was collected to analyze PLCs that are involved in R&D activities, focusing on the R&D intensity for the previous two years (see Table 1). There are a total of 963 PLCs in Malaysia, compared to 744 in Taiwan and 771 in Singapore as at 2012. The percentage of companies investing in R&D

activities in 2012 is 14% in Malaysia, 69% in Taiwan and 12% in Singapore. The findings also reveal that the number of companies with R&D expenditure in Malaysia is decreasing whereas in Taiwan it has been increasing, from 515 companies in 2011 to 533 companies in 2012, an approximate 3% increase. This reveals that more efforts are required by the authorities to encourage companies to invest in R&D in Malaysia.

R&D intensity is commonly defined as R&D expenditure as a percentage of turnover. Based on the two-year analysis, the summary data (see Table 1) reveals that Malaysia's R&D intensity is behind Taiwan's and slightly ahead of Singapore's. Taiwan, which has higher annual R&D expenditure, has more than 1% R&D intensity as compared to Malaysia's which is between 0.65% to 0.85%, and Singapore's is less than 0.05%. The findings also indicate that the R&D intensity in Malaysia had dropped significantly from 0.083% to 0.065% which is a 21% decrease, whereas Taiwan only experienced a minor drop in 2012. The drop in R&D intensity may be due to the financial crisis which began in 2008 and worsened in 2011, resulting in decreased R&D expenditure for developing countries like Malaysia, consistent with the drop in global demand (OECD, 2011). This caused a reduction in productivity which in turn reduced revenue and created financial constraints as Malaysian organizations are very manufacturing oriented. The situation was the opposite in Singapore and Taiwan, as R&D intensity in Taiwan only experienced a minor drop in 2012, while Singapore experienced a slight increase in 2012. This indicates that organizations in Taiwan and Singapore not only focused on manufacturing, but also utilize R&D activities for continuous improvement and sustainable development.

For the industry analysis, the results reveal that the top five industries were the main source of R&D expenditure for the countries as it accounted for at least 70% of annual R&D expenditure (see Table 2). Taiwan's results are significant as more than 90% of its R&D expenditure came from its top five industries, a statistic that has been maintained for two years. Singapore's top five industries' R&D expenditures are between 80% and 85% of the annual R&D total while Malaysia's is between 70% and 80%. There are more than 20 industries in each country, showing that the remaining industries only contributed a relatively low amount of the annual R&D expenditure. Another important finding is the type of industry sectors from the top five industries' R&D expenditures in Malaysia, Singapore and Taiwan. The findings reveal that each country has very different sector specializations, possibly due to the geographical location, infrastructure, competition as well as the country's capabilities.

Table 1 R&D spending of Malaysian PLCs from financial years 2011 - 2012

	Malaysia (RM'000,000)		Singapore (RM'000,000)		Taiwan (RM'000,000)	
	2012	2011	2012	2011	2012	2011
Number of PLCs with R&D spending	139	172	212	209	54	56
% of PLCs with R&D spending	14%	18%	12%	12%	69%	70%
Total R&D	507.356	666.275	4.869	4.354	30,733	28,740
Total Revenue of PLCs	779,378	798,546	18,988	17,993	1,942,858	1,787,752
R & D / Turnover (%)	0.065%	0.083%	0.026%	0.024%	1.582%	1.608%

Source: Adapted from Company Annual Reports, 2011 - 2012

For example, the plantation industry (essentially palm oil) has the highest R&D expenditure in Malaysia, contributing a significant amount of the country's Gross Domestic Product (GDP), and the involvement of public sector bodies like FELDA (Federal Land Development Authority) in the R&D activities (Sabri, 2012).

Table 2 R&D spending of top 5 industries from financial years 2011 - 2012

	Malaysia (RM'000)		Singapore (RM'000)		Taiwan (RM'000,000)	
	2012	2011	2012	2011	2012	2011
Number of PLCs in the top 5 industries	63	86	34	26	381	369
% of PLCs in top 5 industries with R&D spending	45%	50%	40%	30%	71%	72%
Total R&D expenditure from top 5 industries	393,646	499,718	3,949	3,650	28,980	27,004
Total Annual R&D Expenditure (RM'000)	507,356	666,275	4,868	4,353	30,734	28,741
Total R&D / Annual R&D (%)	77.59%	75.00%	81.12%	83.83%	94.29%	93.96%

Singapore has a large presence in construction and building materials, with a significant amount of R&D expenditure, largely due to the high demand, limited land capacity and an increase in the country's population which has created a need for R&D in the construction sector in order to reduce the building and materials cost and reduce the time taken for construction. In Taiwan, the semiconductor and ICT industries are the two most important industries. This is partly due to the intense competition and short technology lifecycles, which forces organizations to invest in R&D in order to outperform each other and fulfil market needs.

Table 3 Industry respondents for each country

Country	Industry	No. of Respondents	Percentage
Malaysia	Plantation	3	37.5%
	Semiconductor	2	25.0%
	ICT	1	12.5%
	Office Equipment	1	12.5%
	Automotive	1	12.5%
	Total	8	
Singapore	E&E	3	42.9%
	Engineering Services	1	14.3%
	Food and Beverages	1	14.3%
	Packaging	1	14.3%
	ICT	1	14.3%
	Total	7	
Taiwan	ICT	3	37.5%
	Semiconductor	2	25.0%
	Optoelectronics	2	25.0%
	E&E	1	12.5%
	Total	8	

2. Quantitative Findings

This section presents the analysis of the primary data collected from the survey questionnaire which was distributed to the top ten organizations in Malaysia, Singapore and Taiwan. The data collected was analyzed in a number

of ways, namely, the background of the respondents, determinants of R&D, readiness for R&D and technology transfer, as well as the propensity of technology transfer in Malaysia, Singapore and Taiwan.

2.1 Respondents' Profile

Thirty copies of the questionnaire were distributed to management, engineers or technologists who have knowledge or experience in R&D and technology transfer operations within the organization. The questionnaire was distributed via email and LinkedIn. Ten questionnaires were distributed to the top ten organizations in each country. The total number of valid and useable questionnaires returned was 23: eight from Malaysia, seven from Singapore and eight from Taiwan. Industries that participated in the survey questionnaire are shown in Table 3 with the majority coming from the plantation sector from Malaysia, the Electrical and Electronics (E&E) sector from Singapore, and the Information and Communications Technology (ICT) sector from Taiwan. The other seven organizations declined to participate in the survey for reasons of confidentiality and the sensitive nature of their organization's R&D information.

2.2 Determinants of R&D and Organization Readiness on R&D and Technology Transfer

Seven factors are identified as the determinants of an organization's R&D expenditure (see Table 4). The results reveal that the availability of funds or cash flow and an organization's market share has a significant impact on determining R&D expenditure, whereas the factors with the least impact are the availability of government subsidies and human capital. This finding is similar to the findings by Bond, Harhoff and Reenen (1999, 2003). The possible reasons that the availability of cash has a significant impact is mainly because R&D is a high risk investment due to the high uncertainty of returns where there is a possibility that the outcomes may not be up to expectation or fail to create an impact in the market. Hence, it is very common that organizations allocate their R&D expenditure based on the availability of extra cash to prepare for loss or worst case scenarios in order to minimize the impact on other investment activities. Organizations also believe that competition has an impact on the amount of R&D expenditure as the more the products fit market needs, the greater market share the organization will gain. This can be achieved by allocating sufficient expenditure to R&D. The findings also indicate that government subsidies have the least impact on R&D expenditure in Taiwan and Singapore whereas human capital has the least impact in Malaysia. This is possibly due to the organization being self-dependent on their funding for R&D rather than expecting help from the governments in the form of tax exemptions. As for the human factor, this may be due to the

availability of many options for conducting R&D activities such as engaging with universities and entering into research contracts, where hiring costs will not be the main concern for organizations.

Table 4 Analysis of determinants of R&D expenditure

Description	Country	SD	Mean	1	2	3	4	5	Total
Firm Sizes	Malaysia	0.463	3.750	-	-	2	6	-	8
	Singapore	0.577	4.000	-	-	1	5	1	7
	Taiwan	0.354	4.125	-	-		7	1	8
Cash flow & Fund Availability	Malaysia	0.835	3.875	-	-	3	3	2	8
	Singapore	0.816	4.000	-	-	2	3	2	7
	Taiwan	0.518	4.375	-	-		5	3	8
Previous Earnings Effects (last annual profit from R&D)	Malaysia	0.744	3.625	-	-	4	3	1	8
	Singapore	0.690	3.857	-	-	2	4	1	7
	Taiwan	0.354	3.875	-	-	1	7		8
Sales Growth / Revenue / Profitability	Malaysia	0.886	3.750	-	-	4	2	2	8
	Singapore	0.690	3.857	-	-	2	4	1	7
	Taiwan	0.463	4.250	-	-	-	6	2	8
Human Capital (hiring budgets)	Malaysia	0.518	3.375	-	-	5	3	-	8
	Singapore	0.756	3.714	-	-	3	3	1	7
	Taiwan	0.518	3.625	-	-	3	5	-	8
Availability of Government Subsidies	Malaysia	0.916	3.625	-	-	5	1	2	8
	Singapore	0.535	3.571	-	-	3	4	-	7
	Taiwan	0.354	3.125	-	-	7	1	-	8
Market Share / Competition	Malaysia	0.707	3.750	-	-	3	4	1	8
	Singapore	0.577	4.000	-	-	1	5	1	7
	Taiwan	0.518	4.625	-	-		3	5	8

1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree
SD – Standard Deviation

In terms of an organizations' readiness in R&D, the results show that Malaysian organizations were in a positive stage of readiness, but still require more effort in order to catch up with Taiwanese organizations (see Table 5). The findings show that Malaysian organizations are lacking in the capabilities of human resources such as personnel performance measurement and people

management tools relating to R&D activities. Although organizations in Malaysia believe that R&D is important, there is still a gap in creating R&D awareness among employees through performance measurement. Employees may feel demotivated and may not work towards achieving the organization's goals if the organization does not express appreciation for their efforts in R&D. People management is another important area for an organization in order to retain and attract competitive employees.

Table 5 Organization's readiness to embark on research and development

		SD	Mean	1	2	3	4	5	Total
Absorptive Capacity	Malaysia	0.463	3.750	-	-	2	6	-	8
	Singapore	1.000	4.000	-	-	3	1	3	7
	Taiwan	0.518	4.625	-	-	-	3	5	8
Simple to Complex Technology Transfer	Malaysia	0.707	3.750	-	-	3	4	1	8
	Singapore	0.488	3.714	-	-	2	5	-	7
	Taiwan	0.535	4.500	-	-	-	4	4	8
Employees 'Know-how'	Malaysia	0.756	4.000	-	-	2	4	2	8
	Singapore	0.976	3.571	-	1	2	3	1	7
	Taiwan	0.354	4.125	-	-	-	7	1	8
Technology Management	Malaysia	0.463	4.250	-	-	-	6	2	8
	Singapore	0.535	3.571	-	-	3	4	-	7
	Taiwan	0.354	4.125	-	-	-	7	1	8
Training	Malaysia	0.886	3.750	-	1	1	5	1	8
	Singapore	0.951	3.286	-	2	1	4	-	7
	Taiwan	0.354	4.125	-	-	-	7	1	8
Learning Culture	Malaysia	0.886	3.750	-	1	1	5	1	8
	Singapore	0.488	3.714	-	-	2	5	-	7
	Taiwan	0.518	4.375	-	-	-	5	3	8
Managing People	Malaysia	1.061	3.625	-	1	3	2	2	8
	Singapore	0.976	3.571	-	1	2	3	1	7
	Taiwan	0.463	3.750	-	-	2	6	-	8
Performance affected by R&D	Malaysia	1.195	3.500	-	2	2	2	2	8
	Singapore	0.900	3.143	-	2	2	3	-	7
	Taiwan	0.463	4.250	-	-	-	6	2	8
Organization believes R&D is important	Malaysia	0.518	4.375	-	-	-	5	3	8
	Singapore	0.378	4.143	-	-	-	6	1	7
	Taiwan	0.354	4.875	-	-	-	1	7	8
Average Mean	Malaysia		3.861						
	Singapore		3.635						
	Taiwan		4.306						

1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree
SD – Standard Deviation

Malaysian organizations which fall behind in this area will face challenges in that their employees may be hired by competitors, resulting in a loss of critical knowledge and R&D projects being suspended due to lack of skilled R&D manpower. This is also highlighted by Jaumotte and Pain (2005) who found that the availability of engineers and scientists matter in terms of R&D success. In Singapore, both technological and people capabilities are still lacking in organizations, especially in terms of training and performance measurement. Training is also an important factor in people capabilities. Without proper and adequate training, it would be difficult to increase an employee's competency level. The employee may also leave the organization to join its competitors which offer training opportunities. In Taiwan, organizations are relatively strong in terms of technological capabilities and people capabilities, and they also have a high absorptive capacity and positive learning culture, but are weak in people management and have less attractive remuneration packages.

2.3 Readiness for Technology Transfer

This last section discusses the organizations' readiness to embark on technology transfer. The findings reveal that Malaysian organizations are the weakest in terms of readiness for technology transfer, mainly due to technology transfer projects failing to translate into sufficient economic impact and benefits. This shows that Malaysian organizations have been poor in transferring the right types of technology to assist organizations in increasing its revenues and gaining leverage from the public sector. The selection of the right technology to transfer is extremely important to ensure that the technology meets the needs of consumers or users (Rouach, 2003).

The analysis of Singapore reveals that, as in Malaysia, organizations are lacking when creating economic impact. However Singaporean organizations seem to be better at enhancing scientific and technical skills and are quicker in transferring a technology. This demonstrates that organizations in Singapore have been very efficient in terms of the technology transfer process, in a timely way. In addition, the findings also reveal that Taiwanese organizations are far ahead of their Malaysian and Singaporean counterparts in terms of readiness and capabilities in transferring technology.

Overall, the results indicate that Taiwanese organizations are much better prepared to embark on R&D and technology transfer. Malaysia's readiness to embark on R&D is higher as compared to Singapore, but Malaysia fares lower in terms of readiness for technology transfers. This shows that although Malaysia has a greater intensity than Singapore in terms of R&D expenditure, Singaporean organizations are slightly more efficient at technology transfer.

Table 6 Organization's readiness to embark on technology transfer

		SD	Mean	1	2	3	4	5	Total
Technology Transfer Cost	Malaysia	0.916	3.375	-	1	4	2	1	8
	Singapore	0.951	3.286	-	2	1	4	-	7
	Taiwan	0.354	4.125	-	-	-	7	1	8
Transfer Speed	Malaysia	0.926	3.500	-	1	3	3	1	8
	Singapore	0.690	3.857	-	-	2	4	1	7
	Taiwan	0.518	4.375	-	-	-	5	3	8
Fits Strategic Needs	Malaysia	0.535	3.500	-	-	4	4	-	8
	Singapore	0.488	3.714	-	-	2	5	-	7
	Taiwan	0.518	4.625	-	-	-	3	5	8
Market Impact	Malaysia	0.926	3.500	-	1	3	3	1	8
	Singapore	1.134	3.429	-	2	1	3	1	7
	Taiwan	0.518	4.625	-	-	-	3	5	8
Economic Development	Malaysia	0.707	3.250	-	1	4	3	-	8
	Singapore	0.951	3.286	-	2	1	4	-	7
	Taiwan	0.518	4.375	-	-	-	5	3	8
Create Opportunity Costs	Malaysia	0.916	3.375	-	1	4	2	1	8
	Singapore	0.535	3.429	-	-	4	3	-	7
	Taiwan	0.354	4.125	-	-	-	7	1	8
Political Rewards	Malaysia	0.707	3.250	-	1	4	3	-	8
	Singapore	0.535	3.571	-	-	3	4	-	7
	Taiwan	0.835	3.875	-	-	3	3	2	8
Enhanced Scientific and Technical Skills	Malaysia	0.756	4.000	-	-	2	4	2	8
	Singapore	0.690	4.143	-	-	1	4	2	7
	Taiwan	0.535	4.500	-	-	-	4	4	8
Average Mean	Malaysia	3.469							
	Singapore	3.589							
	Taiwan	4.328							

1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree
SD – Standard Deviation

2.4 Propensity of Technology Transfer

The findings reveal that the number of technology transfers varies with the amount of R&D expenditure in Malaysia and Singapore where some organizations with higher R&D expenditures have a lower number of technology transfers than those with lower R&D expenditures (see Figure 1). There are no significant results to show that higher R&D expenditures would lead to a higher propensity of technology transfer in Malaysia and Singapore.

However, organizations in Taiwan with higher R&D expenditures have a greater propensity of technology transfer.

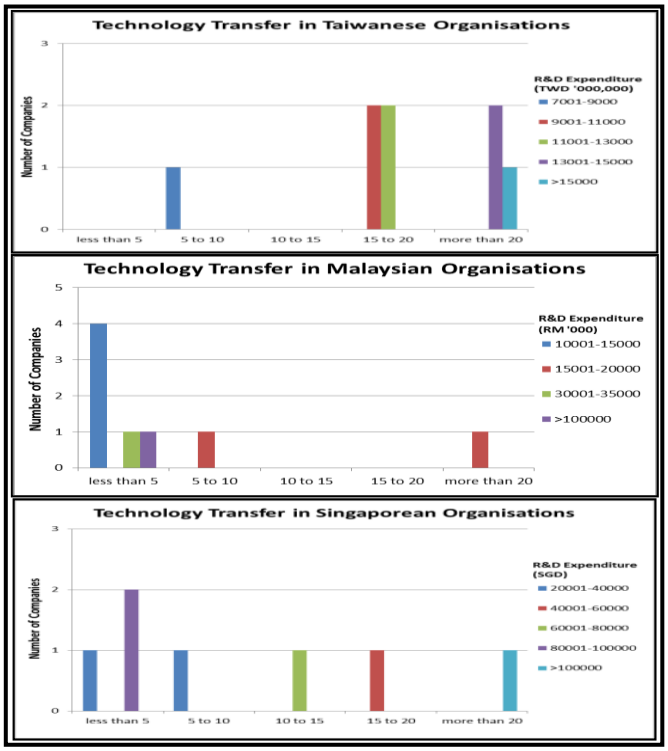

Figure 1 Technology transfer by R&D Expenditure

Another important finding from the survey is related to industrial sector technology transfer (see Table 7). The findings reveal that different industry sectors have different propensities of technology transfer. We found that the number of technologies transferred to-date ranged from zero to more than twenty. There are, however, a few similarities among industries, such as in the semiconductor and E&E industries, both of which are technologically sophisticated and have a higher propensity for technology transfer in Malaysia, Singapore and Taiwan. The findings also indicate that the less technologically advanced industries such as plantations, office tools and equipment, automotive, engineering services and food and beverage industries generally have a low propensity for technology transfer. The differences between industries are mainly due to variations among them in terms of the rate of change in technology, technology lifecycles and testing lead time. This can be

seen in the semiconductor, E&E and optoelectronics industries where the technology lifecycle is rather short as products are constantly being improved. For industries such as the automotive and plantation industries, a long testing lead time involving crash tests and lab testing indirectly affects the propensity of technology transfer of the entire industry.

Table 7 Summary of propensity of technology transfer by industry

Industry	Country		
	Malaysia	Singapore	Taiwan
Plantation	Less than 5	-	-
ICT	5 to 10	5 to 10	15 to 20
Semiconductor	More than 20	-	More than 20
Office Tools / Equipment	Less than 5	-	-
Automotive	Less than 5	-	-
E&E	-	More than 20	More than 20
Engineering Services	-	Less than 5	-
Food and Beverages	-	Less than 5	-
Packaging	-	10 to 15	-
Optoelectronics	-	-	More than 20

The primary data analysis has identified the relationships between R&D expenditure and the propensity of technology transfer as well as the industry sectors and the propensity of each for technology transfer. Overall, the findings indicated that there is no relation between organization's R&D expenditure and its propensity of technology transfer in Malaysia and Singapore. However, there is a relation between organization's R&D expenditure and its propensity of technology transfer in Taiwan.

V. Conclusion and Recommendations

R&D, as a primary source of technological development, is extremely important for an organization's sustainable development and it must be supplemented by effective technology transfer mechanisms. The process from R&D to commercial application is crucial for the success of R&D so the efforts and investment on R&D would not be wasted but instead be beneficial to the organization as well as to the consumers. One important finding of this study is that Taiwanese companies' R&D intensity is the highest among the

three countries studied followed by Malaysia and Singapore. Another important finding is that the availability of funds or cash flow, market share or competition are the main determinants of an organization's R&D expenditure in all three countries, whereas the availability of government subsidies and human capital have the least impact as determinants.

With regard to an organization's readiness for R&D and technology transfer, Taiwanese organizations are much more prepared than organizations in Malaysia and Singapore. Malaysian organizations are ahead of Singapore in terms of readiness for R&D. However, Malaysia still lags behind Singapore in terms of readiness for technology transfer. The findings also reveal that a higher propensity of technology transfer does not necessarily come from organizations with high R&D expenditure in Malaysia and Singapore. This, however, was the opposite for Taiwan. This verifies the hypothesis of this research study which is that there is no relation between industrial R&D expenditure and the propensity of technology transfer in Malaysia and Singapore. The converse is true of Taiwan, where a relation is found between industrial R&D expenditure and the propensity of technology transfer.

In order to enhance the efficiency and effectiveness of R&D and technology transfer, it is recommended to carry out a feasibility study before commencing an R&D project with the involvement of a broad range of personnel such as sales and marketing teams, quality teams and production teams to gauge the potential effectiveness of the R&D. It is a useful way to identify the strengths and weaknesses of the research project, customer needs, commercial viability of the outcomes, and most importantly, to apply previous lessons learnt and set clear goals for the R&D project which would help reduce the risk of the R&D and technology transfer project failing. In addition, setting up a team of people, unit or department with effective technology management through a specific model or set of procedures that suits the organization is also essential for managing the entire technology transfer process. This will enhance the efficiency and effectiveness of the transfer process as the tasks are more focused and the objectives are clear. Finally, improving awareness through technology transfer workshops and seminars will help improve the common understanding among employees of certain desirable values and establishing Standard Operating Procedures. All this is extremely important to ensure the organization is capable of meeting its operational needs especially its ability to enhance its technological and people capabilities to facilitate continuous improvement and sustainable development.

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Appendix 1 Top 10 PLCs R&D spending for financial year 2011-2012 in Malaysia, Singapore and Taiwan

	Malaysia (RM'000)				Singapore (SGD)				Taiwan (TWD'000)			
	2012		2011		2012		2011		2012		ear 2011	
	Company	RM	Company	RM	Company	SGD	Company	SGD	Company	TWD	Company	TWD
1	Sime Darby Berhad	135,800	Proton Holdings Berhad	114,648	Sekisui House Limited	847,388	Sekisui House, Ltd.	900,039	Taiwan Semiconductor Manufacturing Co., Ltd.	38,788,245	Taiwan Semiconductor Manufacturing Co., Ltd.	31,594,034
2	Tenaga Nasional Berhad	46,900	Sime Darby Berhad	110,900	TPV Technology Limited	348,767	TPV Technology Limited	161,840	HTC Corporation	13,780,378	HTC Corporation	13,780,378
3	Genting Plantation Berhad	32,144	Tenaga Nasional Berhad	54,100	Singapore Technologies Engineering Limited	95,716	Singapore Technologies Engineering Ltd	96,248	MediaTek Inc.	13,051,340	MediaTek Inc.	13,448,835
4	Green Packet Berhad	17,590	Pelikan International Corporation Berhad	27,449	Chew's Group Limited	82,225	Amcor Group	93,200	Hon Hai Precision Ind. Co., Ltd.	11,478,794	Hon Hai Precision Ind. Co., Ltd.	12,622,338
5	Malaysian Pacific Industries Berhad	17,468	YTL Power International Berhad	23,030	Fosun International Limited	71,308	Creative Technology Ltd	86,364	Wistron Corporation	11,252,487	Wistron Corporation	11,051,558
6	Pelikan International Corporation Berhad	14,088	Genting Plantations Berhad	21,063	Amcor Group Limited	68,100	Fosun International Limited	62,051	Innolux Corporation	10,751,038	United Microelectronics Corp.	8,976,209

7	Vitrox Corporation Berhad	13,741	Malaysian Pacific Industries Berhad	20,819	Creative Technology Limited	48,751	Longcheer Holdings Limited	56,842	AU Optronics Corp.	9,384,913	Innolux Corporation	8,682,421
8	Kuala Lumpur Kepong Berhad	13,667	Box-Pak Malaysia Berhad	16,700	IBA	38,095	IBA	41,313	United Microelectronics Corp.	9,307,149	Nanya Technology Corporation	8,598,828
9	YTL Corporation Berhad	12,965	IQ Group Holdings Berhad	12,849	Longcheer Holdings Limited	33,721	Venture Corporation Limited	29,550	Quanta Computer Inc.	7,529,658	AU Optronics Corp.	8,088,775
10	Boustead Holding Berhad	10,200	Kuala Lumpur Kepong Berhad	12,641	Beijing Enterprises Water Group Limited	27,600	DMX Technologies Group Limited	17,210	Compal Electronics Inc.	6,495,930	Quanta Computer Inc.	6,985,769
Total R&D spending of Top 10 PLCs		314,565		414,199		1,661,670		1,544,657		131,819,932		123,829,145
% of Total R&D spending of Top 10 PLCs against Total PLC R&D spending		62%		62%		84%		86%		45%		45%

Source: Adapted from company annual reports, 2010-2012.