Promoting Knowledge Transfer in Science and Technology: A Case Study of Technology Park Malaysia (TPM)

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Abstract

Knowledge transfer can be defined as a process of knowledge creation and application, knowledge mobilization and exchange, information search and transformation as well as the learning process at and outside the workplace. The success of companies in a knowledge-based economy relies more on knowledge and intellectual capital than on other resources. Therefore, transferring new knowledge from foreign multinational corporations (MNC) to the local workforce is a basic step for sustaining competitive advantages. Success in knowledge transfer depends on employee absorption capacities, organizational learning climate, and the willingness of foreign expatriates in MNCs to transfer knowledge. Using the case study of Technology Park Malaysia (TPM), this paper investigates to what extent knowledge inflows and outflows have taken place among the professional Malaysian workforce. It also analyzes the factors influencing knowledge transfer.

Keywords: knowledge transfer, organizational learning, employee absorption capacities
JEL classification: D83, O14, O31, O32

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1 Introduction and Research Objectives[1]

Malaysia has recognized knowledge workers as the most important element in the process of developing advanced technologies, improving productivity, and attracting foreign direct investment (FDI) (Fong Chan Onn, 2006; Kanapathy, 1997; Malaysia, 2002; 2001a; 2001b; Tan and Gill, 2000). The success of companies in a knowledge-based economy relies more on knowledge and intellectual capital than on other resources (Carnoy, 1998; Davies and Guppy, 1997; Lewin, 1998; Lubit, 2001; Malaysia, 2006; Sieh, 2000; Varma, 1999). Therefore, transferring knowledge from foreign multinational corporations (MNC) to the local workforce is a basic step for sustaining competitive advantages. Knowledge can be transferred from an individual, team, department, or from one geographical location to another (Argote et al., 2000). This study provides an empirical analysis of knowledge inflows and outflows of the Bumiputera professional workforce at Technology Park Malaysia (TPM). Specifically, the focus of this study is to:

- investigate the inflows of knowledge from MNCs to the local professional workforce;
- identify the outflows of knowledge from the local professional workforce to foreign organizations;
- examine the influence of employee absorption capacities, organizational learning climate and the capability of expatriates regarding knowledge inflows and outflows.

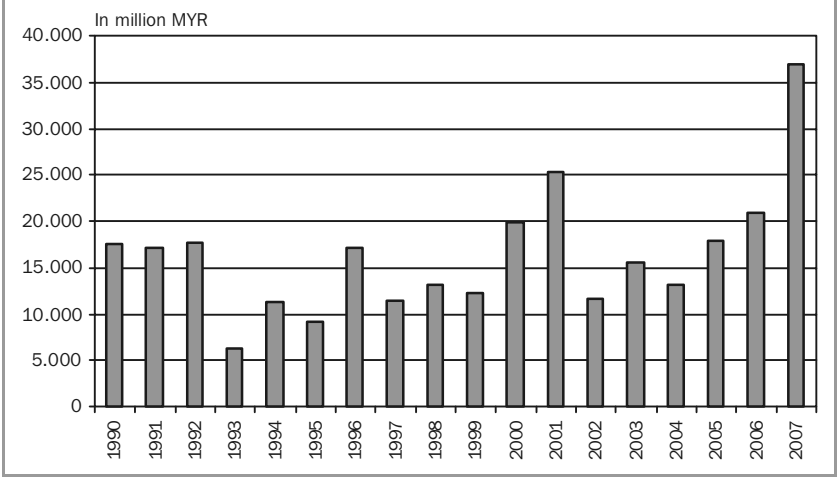
2 Foreign Direct Investment and Knowledge Transfer Incentives

The export-driven industrialization in the early 1990s and special incentives have attracted substantial foreign direct investment. In terms of foreign direct investment in manufacturing, total investments increased annually by 6.1 percent, from MYR 17,629 million in 1990 to MYR 36,923 million in 2007. This has

[1] *This research was supported by the Ministry of Science, Technology and Innovation (MOSTI), Malaysia. We are grateful to the research executives at Technology Park Malaysia (TPM), Multimedia Super Corridor (MSC), Kulim High-Tech Park Corporation (KHPC), and Professor Martin Schulz for their valuable contributions.*

resulted in a strong job creation, employment growth, and the inflow of expatriates. The foreign expatriates in Malaysia occupy high managerial posts, intermediate managerial and professional posts as well as non-executive jobs requiring specific skills. The number of expatriates has increased to 35,480, with 53 percent of them working in the service sector (Nair and Jantan, 2006). FDI has played a critical role in generating employment, capital investments, exports, labor knowledge and skills as well as technology spin-offs in Malaysia (UNCTAD, 2003).

Figure 1 **Foreign Investment in Manufacturing**



Source: Malaysia Industrial Development Authority (1991-2007).

Table 1 **Investment and Knowledge Transfer Incentives for Companies**
Provide world-class physical and information infrastructure.
Allow unrestricted employment of local and foreign knowledge workers.
Ensure the freedom of ownership by exempting companies with MSC Malaysia Status from local ownership requirements.
Give the freedom to source capital globally and the right to borrow funds globally.
Provide financial incentives, including no income tax for up to 10 years or an investment tax allowance, and no duties on imports of multimedia equipment.
Provide globally competitive telecommunications tariffs.
Provide an effective one-stop agency – the MIDA and Multimedia Development Corporation (MDec).
Double deduction for in-house or at approved training institutions.
Deduction for pre-employment training.
Deduction for cash contributions to non-profit oriented technical or vocational training institutions.
Human Resource Development Fund (HRDF).
Special industrial building allowance for approved industrial, technical or vocational training.

Source: MIDA (2008), Multimedia Development Corporation (MDec) (2004, 2008).

As shown in Table 1, special incentives have been provided to attract investors, mainly from foreign multinational companies (MNCs).

3 Technology Park Malaysia (TPM)

Technology parks have appeared in Malaysia since the late 1980s (UNCTAD, 2003). Technology Park Malaysia (TPM) was established to allow high-tech local companies to become global multinationals. This reflects the Malaysian Government's aspiration to create a technology intensive and knowledge-based economy, as set out in the Knowledge-Based Master Plan (Malaysia, 2002) and the Ninth Malaysia Plan 2006-2010 (Malaysia, 2006). TPM was designed to be the world's most comprehensive center for technological innovation and R&D for knowledge-based industries. It was established in 1988 as an agency under the Ministry of Science, Technology and the Environment (MOSTI) and was owned by the Ministry of Finance. However, it was privatized and officially opened on September 1, 1996 (TPM, 2008; MTC, 2004). TPM's objectives are:

- to incubate and nurture knowledge-based enterprises by providing expertise and support services technically and commercially;
- to facilitate R&D, innovation, and commercialization activities by providing advanced infrastructure, equipments, and facilities;
- to promote and stimulate an intellectual, creative, and innovative community for the development of knowledge-based economy by creating a conducive technology park environment;
- to facilitate the government and private sector smart partnerships in technology development and the commercialization of research results;
- to provide a platform for the establishment of strategic business and technology linkages among research institutes, academia, financial community, and industry - both locally and globally (TPM, 2008).

TPM is located on a site of more than 600 acres at Bukit Jalil, close to Kuala Lumpur. TPM is in the heart of Multimedia Super Corridor (MSC) and close to the new Federal Government Administrative Center Putrajaya, intelligent city

Cyberjaya, and Kuala Lumpur International Airport (KLIA). It has a good transportation network and is linked to two major highways. The park is connected with the North-South highway, Port Klang West Port, Kuala Lumpur Airport Cargo Terminal, and public transport facilities. Currently, TPM has 12 smart facilities using solar energy to power its entire network system. Other facilities include a gymnasium, convenience stores, food outlets, banks, a clinic, a kindergarten, and an engineering college (TPM, 2008).

TPM supports the establishment of smart partnerships between large companies and small and medium-sized industries to ensure innovations. It offers venture capital funds and three strategic programs - Innovation House, Incubator Center, and Enterprise House. The Innovation House is designed for individual entrepreneurs, scientists, software developers, innovators, and start-up entities at the pre-production stage. The Incubator Center is tailored for companies that are ready for market testing and production. The Enterprise House is intended for companies or enterprises expanding from the other two programs (TPM, 2008).

TPM's infrastructure, equipment, and services focus on fields of engineering, information technology, and biotechnology. Malaysian Advanced Science, Technology, Engineering, and Research Center (MASTER Center) at TPM plays a major role in engineering development. TPM also organizes various training programs in the fields of robotics and flexible manufacturing systems, and provides specialized engineering services in laboratories, the precision machining center, rapid prototyping center, plastic injection molding center, and metal stamping center. In addition, TPM's focus includes R&D in food and feed production, biodiversity prospecting, alternative medicine, pharmaceuticals, and genetic engineering (TPM, 2008). Currently, 135 companies are located at this technology park, with the overall occupancy rate of 95 percent. MNCs occupy 16 percent of the park and local companies 84 percent. Seventy seven percent of the companies focus on information technology, 5 percent on telecommunications and electronics, 5 percent on biotechnology, 5 percent on engineering, and 6 percent on environmental technology and commercial activities (TPM, 2008).

4 Methodology

Data have been collected through a self-administrated survey on 100 Bumiputera professionals (75 percent responded) at 23 foreign MNCs in TPM. These professionals are involved in research and development. The survey questionnaire was adapted to standard instruments (Mikkelsen and Gronhaug, 1999) taking into account the extensive reviews of relevant research (Chua and Pan, 2008; Chiang, 2007; Foss and Pedesen, 2002; Gilbert and Cordey-Haye, 1996; Gray and Meister, 2006; Harzing and Noorderhaven, 2006; Hsin, Peng-Hsian and Mazzuchi, 2006; Jassimuddin, Klein and Connell, 2005; Lin, 2007; Lubit, 2001; Lucas, 2006; Minbaeva and Michailova, 2004; Tang, Mu and Maclachlan, 2008; Vance and Paik, 2005). Experts from Multimedia Super Corridor (MSC), Kulim High-Tech Park, (KHP), TPM, foreign MNCs, and the University of British Columbia, Canada reviewed and validated the survey questionnaire. Finally, 10 items with high reliability were used to measure the inflow and outflow of knowledge. The respondents were asked to indicate on the five-point Likert scale – from 1 (strongly disagree) to 5 (strongly agree) – the extent to which they engaged in the transfer of knowledge. We have analyzed the data using descriptive statistics to explain the respondents' background and knowledge transfer activities, and used paired sample t-tests to compare knowledge inflows and outflows. We employed multiple regression analysis to identify significant predictors of knowledge transfer.

5 Theoretical Framework

Knowledge transfer is based on the collaboration of different stakeholders and their mutual interaction. Nonaka's (1994) Dynamic Theory of Organizational Knowledge was used as a theoretical background for the knowledge transfer process. Organizational learning theory set by Argyris and Schön (1978), and extended by Argote and Ingram (2000), Argote (1999), and Nonaka and Takeuchi (1995), provides the relevant factors of transferring knowledge from foreign MNCs to the local workforce as well as from the local workforce to their parent company and peer subsidiary company. The relevant literature also deals with joint ventures and strategic alliances (Powell, Koput and Smith-Doerr, 1996), mergers and

acquisitions (Haunschild and Miner, 1997) as modes of inter-organization knowledge transfer.

Knowledge transfer mechanisms include personnel movement, guided learning-by-doing, learning by observation, in-house or off-house training, replication and innovative activities, scientific publications and presentations, interaction among employees (team work), working with experts/expatriates and coaches/mentors, alliances and inter-organization relationships (Hsin, Peng-Hsian and Mazzuchi, 2006; Foss and Pedesen, 2002). Companies encourage promotion and compensation system, organizational learning culture, employee absorption capacities, and social capital (Chiang, 2007; Dayasindhu, 2002; Gopalakrisnan and Santoro, 2004; Lubit, 2001; Lucas, 2006; Seidman and McCauley, 2005; Ward, 2007), which are the predictors of knowledge transfer. However, Gupta and Govindarajan (2000) consider employee absorption capacities as the prime factor in determining knowledge inflows.

6 Results and Discussion

This section presents descriptive statistics and explains the background of companies and respondents in this study. Regarding the company status, 38.7 percent of the respondents work in the headquarters, 32 percent in subsidiary companies, and 26.7 percent in branch companies. Most of the Bumiputera professionals hold a bachelor's degree and 14.7 percent of them are master's degree holders. Majority of the respondents have been trained at local higher learning institutions. Only 32.0 percent hold foreign degrees. As is shown in Table 2, 9.3 percent of the respondents earn less than MYR 2,000.00 a month, 52 percent between MYR 2,001 and MYR 4,000, 25.3 percent between MYR 4,001 and MYR 6,000, and the rest more than MYR 6,001.

Table 2 **Respondents' Characteristics**		
	Frequency	**Percent**
Highest Educational Achievement		
Master's Degree	11	14.7
Bachelor's Degree	64	85.3
Total	75	100.0
Type of Education Institution		
Foreign higher education institution	24	32.0
Local higher learning institution	50	66.7
No response	1	1.3
Total	75	100.0
Gross Salary (Monthly)		
≤ MYR 2,000	7	9.3
MYR 2,001 - MYR 4,000	39	52.0
MYR 4,001 - MYR 6,000	19	25.3
MYR 6,001 - MYR 8,000	2	2.7
MYR 8,001 - MYR 10,000	5	6.7
≥ MYR 10,001	3	4.0
Total	75	100.0

Source: Survey 2008.

The respondents' language proficiency is shown in Table 3. The Malay language is the most proficient, followed by English and Mandarin. This is not a surprise since most of the respondents are Malaysians.

Table 3 **Language Proficiency**					
Language	**Poor**	**Moderate**	**Good**	**Excellent**	**Do not speak the language**
Malay	-	1.3	16.0	81.3	1.3
English	-	1.3	40.0	57.3	1.3
Mandarin	28.0	13.3	8.0	4.0	46.7
Japanese	37.3	4.0	4.0	-	54.7
Arabic	30.7	6.7	2.7	-	60.0
German	33.3	4.0	-	-	62.7
Korean	32.0	1.3	-	-	66.7
French	-	-	2.7	-	97.3
Russian	-	-	1.3	-	98.7

Source: Survey 2008.

Table 4 indicates activities that are related to the knowledge transfer in which the respondents have participated. As it shows, the respondents have not often participated in these programs although their participation slightly increased between 2006 and 2007 in some programs (such as international conferences/

seminars, international workshops/dialogs, company showcases/exhibitions, site visits, overseas work assignments, and in-service courses).

Table 4 **Participation in Knowledge Transfer Activities**

Programs	Overseas				Malaysia			
	2006		2007		2006		2007	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
International conference / seminar								
Not participated	66	88.0	55	73.3	47	62.7	35	46.7
1-2	9	12.0	20	26.7	26	34.7	30	40.0
> 3	-	-	-	-	2	2.7	10	13.3
Total	75	100.0	75	100.0	75	100.0	75	100.0
International workshop / dialog								
Not participated	66	88.0	63	84.0	47	62.7	42	56.0
1-2	8	10.7	11	14.7	18	24.0	26	34.7
> 3	1	1.3	1	1.3	10	13.3	7	9.3
Total	75	100.0	75	100.0	75	100.0	75	100.0
Company showcase /exhibition								
Not participated	67	89.3	61	81.3	43	57.3	44	58.7
1-2	6	8.0	11	14.7	18	24.0	26	34.7
> 3	2	2.7	3	4.0	14	18.7	5	6.6
Total	75	100.0	75	100.0	75	100.0	75	100.0
Company meeting								
Not participated	66	88.0	57	76.0	39	52.0	37	49.3
1-2	9	12.0	16	21.3	22	29.3	20	26.7
> 3	-	-	2	2.7	14	18.7	18	24.0
Total	75	100.0	75	100.0	75	100.0	75	100.0
Negotiation in technological equipments								
Not participated	70	93.3	61	81.3	44	58.7	46	61.3
1-2	5	6.7	13	17.3	20	26.7	19	25.3
> 3	-	-	1	1.4	11	14.6	10	13.4
Total	75	100.0	75	100.0	75	100.0	75	100.0
Site visit								
Not participated	67	89.3	60	80.0	45	60.0	35	46.7
1-2	7	9.3	14	18.7	19	25.3	30	40.0
> 3	1	1.4	1	1.3	11	14.7	10	13.3
Total	75	100.0	75	100.0	75	100.0	75	100.0
Overseas work assignment								
Not participated	61	81.3	55	73.3	54	72.0	52	69.3
1-2	12	16.0	15	20.0	17	22.7	19	25.3
> 3	2	2.7	5	6.7	4	5.3	4	5.4
Total	75	100.0	75	100.0	75	100.0	75	100.0
In-service short course								
Not participated	68	90.7	60	80.0	43	57.3	41	54.7
1-2	6	8.0	12	16.0	28	37.3	31	41.3
> 3	1	1.3	3	4.0	4	5.4	3	4.0
Total	75	100.0	75	100.0	75	100.0	75	100.0

Source: Survey 2008.

The output of knowledge transfer activities is shown in Tables 5, 6, and 7. The total number of filed patent applications increased from 2006 to 2007, while the number of granted patents was higher in 2006 compared to the following year. We have found a small number of license options and licenses executed, but the number increased between 2006 and 2007.

Table 5 **Patents and Licenses**

Output	2006		2007	
	Frequency	Percent	Frequency	Percent
New patent applications				
No response	54	72.0	47	62.7
1-2	166	21.3	20	26.7
3-4	4	5.3	7	9.3
5-6	1	1.4	1	1.4
>7	-	-	-	-
Total	75	100.0	75	100.0
Patent granted by this company				
No response	47	62.7	54	72.0
1-2	21	28.0	12	16.0
3-4	5	6.7	6	8.0
5-6	1	1.3	1	1.3
>7	1	1.3	2	2.7
Total	75	100.0	75	100.0
License options and licenses executed				
No response	51	68.0	46	61.3
1-2	17	22.7	17	22.7
3-4	5	6.7	7	9.3
5-6	1	1.3	3	4.0
>7	1	1.3	2	2.7
Total	75	100.0	75	100.0

Source: Survey 2008.

Table 6 exhibits the number of invitations and awards received by the respondents. It is assumed that the respondents who have received invitations and awards have superior knowledge in their fields. The number of invitations to the experts increased from 23 percent in 2006 to 28 percent in 2007. Innovation awards also exhibit an increase at the frequency of 1 to 2 and 3 to 4.

Table 7 shows the number of published and/or presented articles of the respondents. The published and/or presented papers are considered to be included in knowledge transfer. Table 7 indicates the number of published and presented papers in international journals or at international conferences/forums/

workshops/dialogs. It may be noted that only a small percentage of the respondents has the output in the form of published articles in international journals or at conferences.

Table 6 **Invitations and Awards**

Output	2006		2007	
	Frequency	Percent	Frequency	Percent
Invitation as an expert				
Never	51	68.0	46	61.3
1-2	17	22.7	21	28.0
3-4	6	8.0	3	4.0
5-6	-	-	4	5.3
>7	1	1.3	1	1.3
Total	75	100.0	75	100.0
Innovation Award				
Never	54	72.0	48	64.0
1-2	12	16.0	15	20.0
3-4	6	8.0	10	13.3
5-6	3	4.0	2	2.7
>7	-	-	-	-
Total	75	100.0	75	100.0

Source: Survey 2008.

Table 7 **Published and Presented Articles**

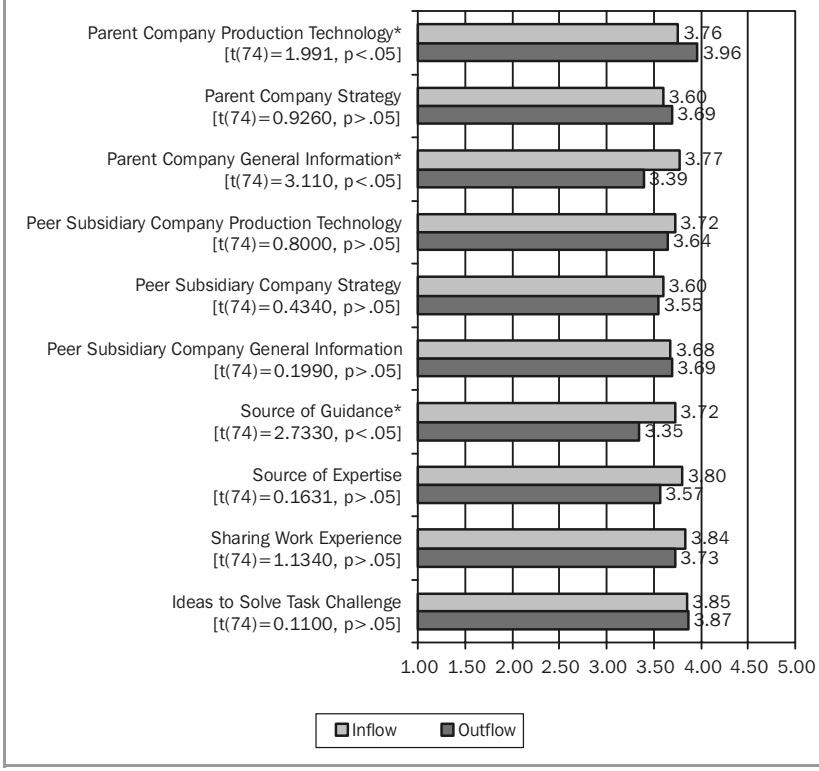
Output	2006		2007	
	Frequency	Percent	Frequency	Percent
International journals				
Never	51	68.0	48	64.0
1-2	16	21.3	17	22.7
3-4	7	9.3	10	13.3
5-6	1	1.4	-	-
>7	-	-	-	-
Total	75	100.0	75	100.0
International Conferences / Forums / Workshops /Dialogs				
Never	49	65.3	45	60.0
1-2	20	26.7	24	32.0
3-4	6	8.0	5	6.7
5-6	-	-	1	1.3
>7	-	-	-	-
Total	75	100.0	75	100.0

Source: Survey 2008.

Empirical results in Figure 2 show that the local workforce is in a win-win situation in the process of knowledge transfer. There is a significant difference in transferring knowledge related to the production technology,

with the outflow of production technology to the parent company being higher than the inflow. It seems that the traditional role of foreign MNCs and foreign peer subsidiary companies as a source of knowledge is no longer prevailing. The local expertise contributes to the foreign MNCs by generating a new technology in terms of input, products, and process development. This finding is consistent with a number of other results in developing countries that focus on promoting technology development (UNCTAD, 2003). However, the local workforce has gained from the knowledge of foreign expatriates. There is a significant difference between the outflow and inflow of knowledge, with the outflow being lower than the inflow.

Figure 2 **Knowledge Inflows and Outflows**



*Note: * Significant at 5 percent.*
Source: Survey 2008.

7 Determinants of Knowledge Transfer

Table 8 exhibits the results of the estimation of the regression model for knowledge inflows. The overall knowledge inflows model shows a strong statistical significance, with $p<0.001$ and the R-square of 0.783. The model explains 78.3 percent of the variance in knowledge inflows from MNCs. Multicolinearity does not appear to be a serious concern since the VIFs for these variables are below 3.0 (Hair et al., 1995), while none of the VIFs for any of the remaining variables exceeded 2.5. The hypothesis assumes that the organizational learning climate, employee absorption capacities, and expatriates' willingness are significantly associated with knowledge transfer. Table 8 shows that the training system ($\beta=0.242$, $p<0.001$), time management ($\beta=0.180$, $p<0.05$), behavioral replication, adaptation and innovation ($\beta=0.175$, $p<0.05$), employee and subsidiary trust ($\beta=0.162$, $p<0.10$), and team work ($\beta=0.142$, $p<0.10$) are positively related to the dependent variable. However, it appears that job autonomy and responsibility ($\beta=-0.166$, $p<0.10$) are negatively related to knowledge inflows. In terms of employee absorption capacity factors, only proficiency in the Mandarin language ($\beta=0.362$, $p<0.05$) and work experience ($\beta=-0.022$, $p<0.05$) are significant predictor variables. However, work experience has an inverse influence on knowledge inflows. The estimated coefficient with expatriate willingness is insignificant ($p>0.10$).

The knowledge outflows model ($R^2=.62$, $F=6.181$, $p<.001$) presented in Table 9 indicates that the training system ($\beta=0.231$, $p<0.05$) as well as behavioral replication, adaptation, and innovation ($\beta=0.373$, $p<0.001$) are positive and significant predictors of knowledge outflows from the local professional workforce. In terms of employee capacity, working experience ($\beta=-0.028$, $p<0.10$) is significantly related to knowledge outflows. Various levels of language proficiency are not significant predictors of knowledge outflows among the professional Bumiputera workforce at Technology Park Malaysia.

Table 8 **Determinants of Knowledge Inflows**		
Independent Variables	**β**	**Std. Error**
Constant	.009	.443
Organizational Learning Climate		
Training system	.242***	.062
Time management	.180**	.072
Behavioral replication, adaptation and innovation	.175**	.066
Job autonomy and responsibility	-.166*	.094
Employee and subsidiary trust	.162*	.086
Team work	.142*	.084
Compensation system	.081	.074
Employee absorption capacities		
Proficiency in Mandarin	.362**	.118
Proficiency in Arabic	-.217	.202
Proficiency in Japanese	-.022	.306
Proficiency in English	.336	.204
Academic qualification	-.018	.109
Type of educational institution	.060	.086
Age	.006	.008
Working experience	-.022**	.011
Expatriate willingness		
Expatriate willingness	.060	.078
R^2	.783	
Adjusted R^2	.721	
F	12.613***	
n	72	

*Notes: *** $p < 0.001$, ** $p < 0.05$, * $p < 0.10$. Dependent variable: knowledge inflows.*

Table 9 **Determinants of Knowledge Outflows**		
Independent Variables	**β**	**Std. Error**
Constant	-.236	.679
Organizational Learning Climate		
Training system	.231**	.095
Time management	.010	.111
Behavioral replication, adaptation and innovation	.373**	.100
Job autonomy and responsibility	.111	.140
Employee and subsidiary trust	.019	.128
Team work	.062	.124
Compensation system	.128	.112
Employee dissemination capacities		
Proficiency in Mandarin	.196	.182
Proficiency in Arabic	-.048	.311
Proficiency in Japanese	.004	.468
Proficiency in English	-.164	.313
Academic qualification	-.035	.166
Type of educational institution	.206	.131
Age	.019	.013
Working experience	-.028*	.017
R^2	.619	
Adjusted R^2	.519	
F	6.181***	
n	72	

*Note: *** $p < 0.001$, ** $p < 0.05$, * $p < 0.10$. Dependent variable: knowledge outflows.*

8 Conclusions and Recommendations

Knowledge transfer at TPM generates advantages for both foreign MNCs and the local professional workforce. However, knowledge-based outputs (patents, licenses, published/presented articles), awards as well as expertise recognition at the international level among the local professional workforce is still at the initial stage. Organizational training system and employee communication skills are the prime factors in receiving and transferring knowledge. Behavioral replication, adaptation, and innovation should be expanded into a sustained knowledge transfer. Our findings show that local professionals prefer guided exploration over independence in the acquisition and sharing of knowledge. In addition, the transfer of knowledge in the workplace setting lies more in personal ties via team work than in individual learning. Team work with expatriates stimulates the process of sharing of ideas, guidance, and experimentation. In order to improve knowledge transfer, companies must allow their employees not only to learn but also to teach their company members. Incentives must be designed to promote in-plant training. In this way, the local professional workforce would gain better knowledge, international experience, and the latest technology development from MNCs.

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