TECHNOLOGY TRANSFER MODEL FOR THE KLANG VALLEY MASS RAPID TRANSIT DEVELOPMENT PROJECT

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DEDICATION

This thesis is dedicated to my parents, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my wife, who taught me that even the largest task can be accomplished if it is done one step at a time. The thesis is also dedicated to my children who gave me the strength and patience that is needed to complete the journey.

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ABSTRACT

Realising the strategic leverage that large-scale public procurement has on local technology development, several countries introduced a Technology Transfer (TT) programme into their public procurement as part of capability-building. Recognising this leverage, the government of Malaysia has also introduced this Technology Transfer programme into some government strategic procurements to develop local industries. Malaysia still depends heavily on foreign technology in certain sectors and this over-reliance is due to the ineffectiveness of the TT model currently being implemented. Arguably, effective implementation of TT by the government would help Malaysia to reduce this dependency. However, there is a lack of studies measuring the effectiveness of TT in Malaysia's public mega-projects. This study provides an analysis of a case study involving the TT model used in a public rail infrastructure project in Malaysia. It aims to identify factors impacting the current effectiveness of the technology transfer process in the nation's mega infrastructure project and propose a framework. The study was conducted using a mixed-method analysis of qualitative and quantitative data. The Klang Valley Mass Rapid Transit (KVMRT) project was selected as a suitable case study due to the massive amounts of capital and technology needed for its completion. The final output of the study is a four-stage TT model for the KVMRT project. The first stage is a literature review in which TT models from several studies were reviewed. Based on this review and comparison analysis, a conceptual KVMRT TT model was developed. To further investigate the key factors of the TT process in the project, two stages of study: primary study 1 and primary study 2 were conducted. Primary study 1 was conducted qualitatively to test and evaluate the conceptual model developed during the early stage with the identified key experts. Primary study 2 was conducted quantitatively using factor analysis and Structural Equation Modelling (SEM) to test and evaluate further the findings from primary study 1. A total of 202 respondents were selected from personnel who were directly involved in the KVMRT project and TT programme to participate in a survey. The fourth stage was the model validation stage, where a focus group and case studies are used to validate the findings from the primary study 2. Based on these findings and the validation exercise, a final KVMRT-TT model was developed. Six main factors that are highly influential were identified in determining the effective and successful outcome of the TT programme in the KVMRT project, namely: "Technology Transfer Planning", "Transfer Environment", "Learning Environment", "Technology Provider's Characteristics", "Recipient's Characteristics" and "Technology Transfer Outcome". Among these factors, the "Learning Environment" was found to be the strongest factor influencing the TT outcome. This study made several recommendations to improve the TT process which include: (1) Improvement of current government policy on Technology Transfer, (2) Focus attention on innovations as one of the main criteria for a TT outcome, (3) Digitalization of the TT Process, (4) Proper measurement and evaluation of TT outcomes, and (5) Establishment of a Technology Transfer Office (TTO) in a government strategic procurement project.

ABSTRAK

Menyedari besarnya pengaruh perolehan kerajaan yang strategik dan berskala besar terhadap pembangunan teknologi tempatan, beberapa negara telah memperkenalkan Pemindahan Teknologi (TT) dalam perolehan awam mereka sebagai sebahagian peningkatan keupayaan. Kerajaan Malaysia dalam memperakui pengaruh ini juga telah memperkenalkan program Pemindahan Teknologi di dalam perolehan strategik kerajaan untuk membangunkan industri tempatan. Malaysia masih sangat bergantung kepada teknologi luar dalam sektor tertentu dan kebergantungan ini disebabkan oleh model TT semasa yang dilaksanakan tidak efektif. Oleh itu, pelaksanaan TT yang berkesan oleh kerajaan akan membantu Malaysia mengurangkan kebergantungan ini. Namun begitu, tiada kajian telah dibuat yang mengukur keberkesanan program Pemindahan Teknologi (TT) di dalam projek mega kerajaan ini. Kajian ini menyediakan analisis berdasarkan satu kes kajian model TT di dalam projek infrastruktur rel di Malaysia. Kajian ini adalah untuk mengenal pasti faktor yang memberi impak kepada keberkesanan semasa proses pemindahan teknologi dalam projek infrastruktur negara dan mencadangkan satu kerangka kerja. Kajian ini menggunakan kaedah analisis bagi data kualitatif dan kuantitatif. Projek Transit Aliran Deras Lembah Kelang (KVMRT) dipilih sebagai kes kajian kerana projek tersebut memerlukan dana awam yang besar dan juga keperluan teknologi untuk menyiapkannya. Hasil akhir kajian ini adalah empat peringkat TT untuk projek KVMRT berkenaan. Peringkat pertama adalah kajian literatur di mana model TT daripada beberapa kajian dikaji. Berdasarkan kajian dan analisis perbandingan, sebuah konsep model TT bagi KVMRT dibangunkan. Bagi menyiasat faktor-faktor penting proses TT di dalam projek, dua peringkat kajian: kajian utama 1 dan kajian utama 2 telah dilakukan. Kajian utama 1 dilakukan secara kualitatif bagi menguji dan menilai model konsep yang telah dihasilkan semasa peringkat awal kajian dengan pakar-pakar yang telah dikenal pasti. Kajian utama 2 pula telah dijalankan secara kuantitatif menggunakan analisis faktor dan *Structural Equation Modelling* (SEM) bagi menguji dan menilai penemuan kajian daripada kajian utama 1. Sebanyak 202 responden telah dipilih daripada kakitangan yang terlibat secara langsung dalam projek KVMRT dan program TT untuk turut serta di dalam soal selidik. Peringkat keempat adalah peringkat pengesahan dengan kumpulan fokus dan juga kajian kes digunakan untuk mengesahkan penemuan daripada kajian utama 2. Daripada penemuan dan pengesahan tersebut, sebuah model akhir KVMRT-TT telah dibangunkan. Terdapat enam faktor penting yang mempengaruhi keberkesanan dan kejayaan hasil program TT di dalam projek KVMRT iaitu: “Perancangan Pemindahan Teknologi”, “Persekitaran Pemindahan Teknologi”, “Persekitaran Pembelajaran”, “Ciri-ciri Pembekal Teknologi”, “Ciri-ciri Penerima Teknologi” dan “Hasil Pemindahan Teknologi”. Di antara faktor-faktor ini, didapati “Persekitaran Pembelajaran” adalah faktor utama yang mempengaruhi hasil TT. Kajian ini mengetengahkan cadangan-cadangan bagi penambahbaikan proses TT termasuklah (1) Penambahbaikan polisi kerajaan bagi Pemindahan Teknologi, (2) Inovasi sebagai fokus dan kriteria utama hasil TT, (3) Digitalisasi proses TT, (4) Pengukuran serta penilaian yang wajar ke atas hasil TT dan (5) Penubuhan sebuah Pusat Pemindahan Teknologi (TTO) di dalam sebuah projek perolehan strategik kerajaan.

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LIST OF ABBREVIATIONS

AC	-	Alternating Current
ANOVA	-	Analysis of Variance
AVE	-	Average Variance Extracted
BIM	-	Building Information Modelling
CFA	-	Confirmatory Factor Analysis
CR	-	Composite Reliability
DC	-	Direct Current
EFA	-	Exploratory Factor Analysis
EIA	-	Environmental Impact Assessment
EOI	-	Export-Oriented Industrialization
ERL	-	Express Rail Link
FAT	-	Factory Acceptance Test
FTZ	-	Free Trade Zone
GIS	-	Gas-insulated Switchgear
GNI	-	Gross National Income
HV	-	High Voltage
ICP	-	Industrial Collaboration Programme
ICT	-	Information and Communication Technology
IMP	-	Industrial Master Plan
IMU	-	ICP Management Unit
IRD	-	ICP Requirement Document
ISD	-	ICP Strategic Document
ISI	-	Import-Substituting Industrialization
KLIA	-	Kuala Lumpur International Airport
KM	-	Kilometres
KMO	-	Kaiser-Meyer-Olkin
KTMB	-	Keretapi Tanah Melayu Berhad
kV	-	Kilovolt
KVMRT	-	Klang Valley Mass Rapid Transit

LRT	-	Light Rail Transit
MIGHT	-	Malaysian Industry Government Group for High Technology
MITI	-	Ministry of International Trade and Industry
MNCs	-	Multi-National Companies
MOF	-	Ministry of Finance
MRT	-	Mass Rapid Transit
OECD	-	Organization for Economic Cooperation and Development
OCS	-	Overhead Catenary System
OEM	-	Original Equipment Manufacturer
OJT	-	On-Job-Training
ORD	-	Offset Requirement Document
OSA	-	Office of Science Advisor
PDP	-	Project Delivery Partner
PEMANDU	-	Performance Management and Delivery Unit
PERODUA	-	Perusahaan Otomobil Kedua
PROTON	-	Perusahaan Otomobil Nasional
QA	-	Quality Assurance
QC	-	Quality Control
R&D	-	Research and Development
SBK	-	Sungai Buloh-Kajang
SCADA	-	Supervisory Control and Data Acquisition
SEM	-	Structural Equation Modelling
SF6	-	Sulphur Hexafluoride
SSP	-	Sungai Buloh-Serdang-Putrajaya
S&T	-	Science and Technology
TDA	-	Technology Depository Agency
TIO	-	Technology Innovation Office
TT	-	Technology Transfer
TTO	-	Technology Transfer Office
UTC	-	University Technology Centre
UTM	-	Universiti Teknologi Malaysia
WPCs	-	Works Package Contractors

LIST OF SYMBOLS

α	-	Cronbach Alpha
$\bar{x}$	-	Mean
r	-	Pearson Correlation Coefficient
σ	-	Standard Deviation

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Leveraging public procurement as a strategic tool for technology development and innovation is not considered as something new (Maleki *et al.*, 2017; Uyarra and Flanagan, 2009). Many countries around the world have utilised their public procurement as a strategic tool for technology transfer and capability-building through mechanisms such as Offset and Counter-trade programmes (Balakrishnan, 2007; Hamdan, 2015). However, studies of the effectiveness of utilising a government's procurement policy to effectively develop local industrial capability, especially at the level of companies and firms, are still lacking (Edler *et al.*, 2013). Therefore, this study aims to develop a technology transfer model in order to study the effectiveness of the technology transfer process in a public infrastructure project based on the government's technology transfer policy.

The technology transfer process itself is not something considered to be new. Technology transfer was already happening during the Neolithic age, where human civilisation was starting to develop new knowledge and technology and transforming themselves from nomadic hunters and gatherers to settled farmers by learning new knowledge and processes (Segman, 1989; Thohari *et al.*, 2013). This new knowledge and technology were often shared with others as ways to create linkages and contact between civilisations. Thus, technology transfer has occurred throughout all civilisations worldwide. For example, Islamic civilisation, as the global leader in scientific knowledge, played a crucial role in providing medical, mathematical and technological knowledge to the western world through several territories such as Al-Andalus and Sicily during the early middle ages (Segman, 1989; Tahri, 2012). This historical fact shows that technology and knowledge transfer occur naturally whenever two civilisations meet. History also shows that technology transfer can trigger an industrial revolution, such as the American industrial revolution during the 19th century. The industrial revolution started from the technology transfer of British textile expertise, technical assistance and operating personnel to America that resulted in faster textile production (Cameron, 1960; Irwin and Moore, 1991; Mohajan, 2019). Therefore, technology transfer has played an important part in shaping the history of the world and the development of countries throughout history. History shows the critical role of technology transfer in the transformation of a country such as Japan after World War Two. The result of a technology and knowledge transfer in the area of quality management from Edwards Deming in the United States to Japan led to Japan's economic revolution (Mandel, 2012). Edwards Deming pioneered quality control techniques in manufacturing and shared them with Japanese automotive manufacturers. The Japanese manufacturers adopted Deming's quality control techniques and later created their own quality control methods (Mandel, 2012). The Japanese manufacturers were able to utilize the knowledge received from Deming and customize it according to their needs and environment. The technology transfer between Deming and the Japanese automotive manufacturers shows that with the right factors and sub-factors in place, the process can lead to a significant outcome that would benefit the economy of a country tremendously. Japanese manufacturers since then have further improved their manufacturing and quality management methods to become a reference for the world.

In the Malaysian local context, technology transfer has always been used by the government as leverage to develop local industries and to transform Malaysia from a developing country to fully developed nation status. The mechanism used by the government to facilitate technology transfer has always been in the form of national policies and guidelines (MOF, 2014). The national policies serve as the governing mechanism for the industries and academia in implementing technology transfer for the benefit of local industries. The government of Malaysia has always used construction projects as a basis for importing technology through international technology transfer (Omar *et al.*, 2008). The construction projects that have attracted top foreign companies to participate in the project have allowed the local construction companies to participate and learn the foreign companies' construction techniques and process. Example of these large infrastructure mega-projects from which the local construction industry has previously benefitted are the Petronas Twin Towers and

Kuala Lumpur International Airport or KLIA (Omar *et al.*, 2010; Omar *et al.*, 2008). The SMART Tunnel construction project in Kuala Lumpur, Malaysia for example has enabled technology transfer from foreign technology to the local industry in adapting a new tunnelling technology methods by leveraging the SMART Tunnel construction (Isah and Ali, 2015).

Technology transfer has also been prominent in other key sectors such as the rail support industry. Due to the Government's effort in modernising the local rail infrastructure in the 1990s, the rail support industry has been the beneficiary of many different rail technologies (MIGHT, 2014a). However, the local railway industry in Malaysia is currently very much dependent on international Original Equipment Manufacturers (OEM), especially in railway systems technology. Only limited amounts of railway systems technology have been produced by local companies, possibly due to the ineffective technology transfer process being implemented (MIGHT, 2014a). At the time the study was conducted, Malaysia's local capability in terms of rail infrastructure systems such as Electric Trains, Signalling Systems, Maintenance, Repair and Overhaul was still critically lacking (MIGHT, 2014a). The study by MIGHT identified the technology gaps for the local railway system. Effective measures by the government are still needed to ensure that this critical technology gap can be closed by the local rail companies in meeting both local and global demands.

A previous study on the technology transfer during Malaysia's Express Rail Link (ERL) project was also conducted (Mohamed *et al.*, 2015). Based on this study, there is already a pocket of local workers who are skilled and knowledgeable in building modern railway infrastructure here in Malaysia (Mohamed *et al.*, 2015). This scenario is due to their involvement in a previous government's rail infrastructure projects such as PUTRA LRT, STAR LRT and the KTM Komuter project. However, the study stated that the pool of skilled workers is most experienced in Light Rapid Transit systems. Therefore, when the government introduced a high-speed rail system, such as the ERL project, local industry was facing significant gaps in technology, knowledge and skill (Mohamed *et al.*, 2015). Based on this, any new railway infrastructure project that uses new rail systems will need to acquire new knowledge and engage in technology transfer. As the government are now developing Malaysia's first and second Mass Rapid Transit rail networks, new rail systems will be introduced into the country accompanied by the need for technology transfer to the local industries to sustain and maintain the rail system in the long run.

Over the years, the government has spent a massive amount of public funds to modernise the rail infrastructure in Malaysia. According to the SPAD Master Plan, the government has invested more than RM50 billion in upgrading the rail systems in the country (SPAD, 2014). This modernisation includes the government's purchase of new electric trains and also rail supporting equipment and systems such as signalling and automated fare collection (Nee, 2013). There have also been several rail network extension projects that extend the current LRT line to cover more areas. However, with all the rail modernisation projects over the years, the local contribution to these projects is significantly low, especially in the rail systems (MIGHT, 2014a). As can be seen in Table 1.1, there is minimal local content, particularly in the rail systems for the three major rail infrastructure projects in the past ten years.

Table 1.1 Local content in major rail infrastructure (Hamdan, 2015; MIGHT, 2014a)

Rail Projects	**Local Content (Percentage)**		
	Rolling Stock	**Systems**	**Infra (Civil Works)**
Kelana Jaya Line Expansion	30%	0 – 19%	100%
Ampang Line Expansion	Nil	Nil	100%
MRT Sg Buloh to Kajang Line	30%	30%	100%

Table 1.1 shows that the local rail operator is still relying heavily upon foreign technology to build the railway infrastructure as can be seen in the LRT extension project, in particular the rail systems utilise less than 30% local content. However, for the KVMRT project, the government has realised the need to increase the local content. Therefore, the government have imposed a mandatory minimum of 30% local content on the project contractors.

The government has also imposed the Offset programme - now known as the Industrial Collaboration Programme (ICP) - requirement on the foreign contractors who have a contract value of more than RM100 million in the KVMRT project (MOF, 2014; MRTC, 2013). By having this mandatory obligation specified in the contract, the foreign contractors have no choice but to offer a proper and structured technology transfer programme to local firms that can be accepted by the government (Hamdan, 2015). In KVMRT line 1, six work packages triggered the Offset programme when awarded to a foreign company with a contract value of more than RM100 million. These packages are the Electric Trains, the Signalling and the Train Control System, the Power Supply and Distribution System, Track Work, Automated Fare Collection and Tunnelling Works (MRTC, 2013). The main objective of the KVMRT Offset programme is to develop Malaysia's local capability and capacity, especially in the areas of rail system technologies. However, based on the study by MIGHT, the local railway industry still heavily relied on foreign OEM's technology and there is still a lack of localization in recent rail infrastructure projects in the country (MIGHT, 2014a). This critical lack of localization, even with several big rail infrastructure project initiated by the government in the past year, shows that there is a need to study whether the technology transfer programme implemented by the works package contractors in the KVMRT project is effective in meeting its intended objectives so that the project will not repeat the failure of past technology transfer programmes in local public railway infrastructure projects.

The KVMRT project is one of the projects that has triggered the mandatory Offset requirement (Nee, 2013). From the tender requirement, most of the rail system works package contractors are required to deliver a technology transfer programme for the local companies to be monitored by the project procurement agency and the government (Nee, 2013). One of the main objectives of the KVMRT Offset programme is to enhance the local rail capability by leveraging a foreign contractor's technology and knowledge. Other objectives include attaching local companies as recipients of the technology transfer programmes with the international companies (MRTC, 2013). From this Offset programme, the government only monitors the intended milestones and deliverables (MRTC, 2013). The soft aspect of the technology transfer programme, such as the critical success factors for an effective technology transfer process, is not being monitored closely. The preliminary assumptions are that the parameters for the efficiency of the technology transfer will be multi-faceted and largely dependent on many factors, including the readiness of local recipients. There are also other interrelated factors in TT as described in previous studies that show that the TT process also depends on the absorptive capacity of the recipient and the pre-existing technology gap (A. Bakar, 2006; Omar *et al.*, 2011).

1.2 Problem Statement

In the context of Malaysia's rail support industry, the nation still depends heavily on foreign technology to develop the local rail infrastructure (MIGHT, 2014a). This over-reliance on foreign rail technology is due to the ineffective technology transfer model currently being implemented by the government to develop the local rail support industry. Even though the government has introduced technology transfer programmes into public procurement, there is still a lack of localization especially in the rail support industry (MIGHT, 2014a). The lack of localization even with numerous public rail projects implemented by the government over the years shows the ineffectiveness of the current technology transfer programmes being implemented in public rail projects. Globally, technology development is increasing at a tremendous rate and therefore technologies are now becoming obsolete faster than before. As the global economy is entering the fourth industrial revolution, the technology disruption will become even more frequent in various industries and sectors. Therefore, the existing technology transfer model might no longer be relevant to support today's faster cycle of technology development. As Choi (2009) has highlighted, the technology transfer model now also needs to incorporate innovation as one of its primary outcomes (Choi, 2009). However, there are still gaps in terms of the connection between the performance of a company and the effectiveness of technology transfer. The gaps can be closed by identifying the factors and sub-factors that influence the technology transfer process from start to finish using a technology transfer model as reference and analysis. Therefore, the main research activity is to identify and measure the current effectiveness of the technology transfer process in the government's rail infrastructure project by studying the key factors and sub-factors affecting the effectiveness in a technology transfer programme by developing a technology transfer model. This Technology Transfer Model can be developed and analysed by identifying the factors and sub-factors related to the technology transfer process and its interrelationships. This model can be developed more accurately by using the quantitative approach where the key success factors and their relationship with other key factors can be identified and analysed. Based on the literature review of the national policies that facilitate technology transfer, there are no studies that have measured the effectiveness of this policy in the country. There is also a lack of studies analysing the effectiveness of technology transfer in a mega-project in Malaysia and how it impacts the local industries. Several studies, such as technology transfer in the ERL project and on the KVMRT project, were conducted based on qualitative methods (Mohamed *et al.,* 2015; Omar *et al.,* 2019). Also, the previous study on the ERL project and KVMRT project did not develop a technology transfer model that takes into account the transfer environment factor, e.g. whether government policy can have a direct or indirect influence on the technology transfer programme in the project. By having a developed KVMRT TT Model, the technology transfer process in the KVMRT project can be further analysed and improved. The effectiveness of the technology transfer process and the outcomes can be quantified by studying and validating a Technology Transfer Model. This can later be used for future public rail project technology transfer programmes as a means to further improve the technology transfer process that would eventually increase the localization of the rail support industry for the nation.

1.3 The Rationale for Developing the KVMRT Technology Transfer Model

In Malaysia, the rail support industry encompasses any rail-related activities such as research, design and development, infrastructure construction, maintenance, repair and overhaul and the final decommissioning of any rail-related types of machinery and vehicles (MIGHT, 2014a). Looking back at Malaysia's rail development timeline and history, as can be seen in Figure 1.1 below, the rail support industry in Malaysia was started exceedingly early even before the country's independence. The first railway track built in the country was in the year 1885 with a total length of 12.8km from Taiping to Port Weld. The British government entirely financed the rail infrastructure and system at that time due to the need for transporting the mined tin to the port (Lowtan and Sussman, 2004).

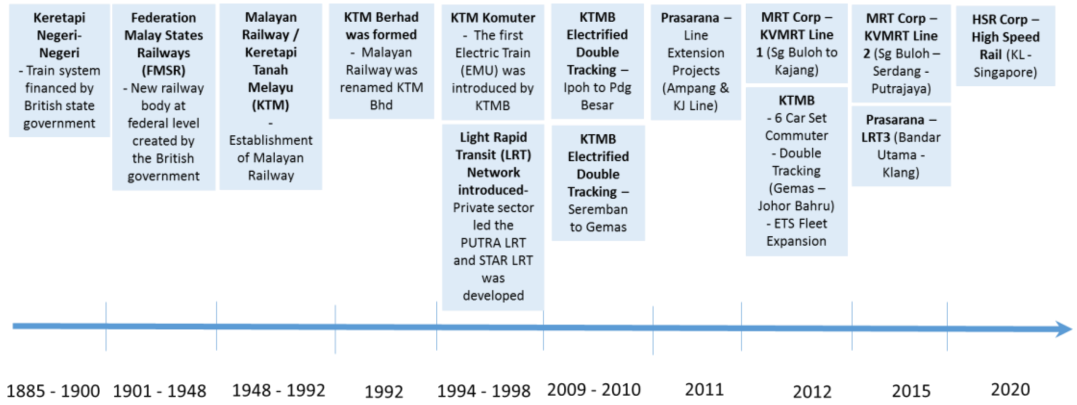

Figure 1.1 Malaysia's railway development timeline (1885 -2020) (Lee and Sipalan, 2018; MIGHT, 2014a; SPAD, 2014)

However, once the country gained its independence, the government formed the "Keretapi Tanah Melayu" or KTM and later during the 1990s, transformed it into "Keretapi Tanah Melayu Berhad" or KTMB (Lowtan and Sussman, 2004). The modernisation of the rail infrastructure only started in 1995 with KTMB's first electrified track with the first electric train operating from Kuala Lumpur and Rawang (Mohamad, 2003). Malaysia also upgraded its rail infrastructure by implementing the Light Rail Transit (LRT) network in the early 1990s. The two LRT systems introduced were the STAR LRT and PUTRA LRT led by the private sector (Mohamad, 2003). In the effort to further upgrade the railway lines in the country, the electrified double-tracking project and also the LRT extension line project were implemented by the government from 2009 to 2011 (Mohamad, 2003). The government has also implemented several other metro lines such as the KVMRT Line 2 that runs from Sg Buloh to Putrajaya and also LRT 3. A new mega-rail-infrastructure development that has been in the planning and implementation mode is the High-Speed Rail Line connecting Kuala Lumpur to Singapore and also the East Coast Rail Line connecting Malaysia's west and east coasts (Lee and Sipalan, 2018; SPAD, 2014). This rail infrastructure project is likely to introduce modern rail system technology into the country on which the local industry can capitalise to grow their capability further.

As the population of the country was growing at a rapid pace, the government realised the need for more public railway infrastructure. According to PEMANDU, the railway infrastructure remains one of the critical components of the economic growth of the country (PEMANDU, 2012). However, the country's dependence on foreign rail technology is still high even though the rail support industry in Malaysia had been established before the country's independence. Malaysia's local rail operator, as well as rail integrator, depends heavily on foreign OEM technologies. As can be seen in the KVMRT Line 1 project, most of the rail system contractors and its technology are from foreign countries (MRTC, 2013). The local companies are still lacking in terms of technology and capability in rail systems such as rolling stock and signalling systems (MIGHT, 2014a). This dependence on foreign technology and systems has resulted in a massive outflow of capital from Malaysia to other countries. This outflow of money can be further reduced if the local industries are capable of supporting the rail infrastructure projects through localization of parts, components and skilled manpower.

The local industries' dependence on foreign technology can be reduced if the government puts in place a proper structure for technology transfer from the foreign OEMs to the local industries. Studies have shown that the local contractors can increase their technical capability by leveraging their working collaboration with the foreign OEMs (A. Bakar, 2006; Omar *et al.*, 2012). The efficiency of technology adoption can be increased if certain factors and sub-factors are introduced into the TT process (Oliveira and Teixeira, 2010; Waroonkun, 2007). Based on Malaysia's previous rail infrastructure projects such as the Express Rail Link (ERL), technology transfer opportunities can be capitalised, especially during the development of the rail infrastructure (Mohamed *et al.*, 2015). With proper planning and a formal structure, the technology that is being introduced by the foreign contractors can be absorbed by the local contractors (A. Khan, 2011; Waroonkun, 2007).

The Klang Valley Mass Rapid Transit Project (KVMRT) is selected as a suitable case study for this research because of the massive public capital used for procurement as well as the technology that is needed to complete the infrastructure development. The KVMRT Lines are also the first Mass Rapid Transit metro line project being developed and built in Malaysia. The previous metro rail project - the LRT project - falls under the Light Rail category. Due to these elements, the project can be considered as an appropriate platform to study the technology transfer process and identify the critical success factors of the process during its planning and implementation phases.

The rationale for developing a technology transfer model for the KVMRT project arises from the lack of such a model for the rail support industry (Dinakar, 2011). Currently, there is no technology transfer model being developed using the quantitative approach in the Malaysian context. There has also been a lack of study in terms of identifying technology transfer factors related to the development of a national rail infrastructure. The literature review of technology transfer models shows that most of the previous studies used a qualitative approach in developing the technology transfer model. Therefore, there is a need to develop a TT model that is based on quantitative data and analysis. With substantial public funds and capital being pumped by the government into mega-construction projects such as KLIA, LRT and KVMRT infrastructure projects, there is a need to study their effectiveness in promoting technology transfer to local industries. There have been technology transfer programmes in other related rail support industry projects in Malaysia, such as LRT and ERL (Mohamed *et al.*, 2015). However, there is a lack of effort to develop a technology transfer model based on a national public rail infrastructure project, especially using quantitative methods and analysis. As more public rail projects begin, a "Technology Transfer Model" for public rail infrastructure projects will benefit the country by improving the technology transfer process and at the same time helping to increase the local rail support industry's capability and knowledge.

Another rationale for selecting the Klang Valley Mass Rapid Transit infrastructure development project as the basis for the development of the technology transfer model is due to the massive public funds being used in its implementation. The KVMRT project is one of the biggest mega-structures ever financed by the government of Malaysia with the Sungai Buloh-Serdang-Putrajaya (SSP) Line budgeted at under RM40 billion (Kaur, 2016). The nature and scope of this large modern rail infrastructure development project will usually attract top players to participate, as can be seen in public rail projects in China (Chan and Aldhaban, 2009). Due to this factor, the KVMRT project serves as an excellent platform for data-gathering using statistical methods due to most of the works package contractors participating in the project being established contractors both domestic and foreign

(Nee, 2013). Foreign contractors participating in the project will bring their internal methods and technologies into the project and therefore will create high value-added activities with which local industries can collaborate and learn (Nee, 2013).

A valid reason for developing the KVMRT technology transfer model is to see the effectiveness of the government's policy in facilitating and governing a technology transfer programme in a public-funded project. The effectiveness of the TT model can be determined using quantitative analysis as previous studies on TT Models have done (Purushotham *et al.*, 2015; Waroonkun, 2007). The existing national policies, such as the ICP policy, have served as the guideline for the procurement agency to implement technology transfer since 2013 (TDA, 2016). Improvements have been made to the policy since then with several amendments being made to the treasury circular in recent years. The improvements to the policy only focus on the mechanism of the ICP monitoring and not on improvements to the effectiveness of the technology transfer process flow (Hamdan, 2015; MOF, 2014). There is also a lack of studies to measure the effectiveness of this policy in ensuring that technology transfer is being implemented successfully in a public project, especially using quantitative analysis. The development of the KVMRT TT model will serve as a future reference for any procurement agencies or government-related bodies to plan and coordinate a TT programme that will effectively meet its intended objectives.

1.4 Research Questions

The research questions of the study that served as the guide for the entire research are as follows: -

1. What are the current process flows of the KVMRT Technology Transfer programme?
2. What are the underlying factors and sub-factors that influence the effectiveness of the KVMRT Technology Transfer process and make it a successful TT programme?

3. What is the validated Technology Transfer Model that can be used for the KVMRT Technology Transfer Process flow and for similar future TT Programmes?

1.5 Research Objectives

The main objectives of the study are as follows: -

1. To identify the current process flows in the Klang Valley Mass Rapid Transit (KVMRT) Technology Transfer programme,
2. To determine the factors and sub-factors that contribute to the effectiveness and success of the technology transfer in the KVMRT development project,
3. To develop a Technology Transfer Model for the KVMRT project,
4. To validate this Technology Transfer Model.

1.6 Scope of the Study

In developing the technology transfer model, the study focuses on the Klang Valley Mass Rapid Transit development project as a case study. Line 1 of the KVMRT line was completed in 2017 (Ahmad and Sivanandam, 2017) and a further line is under construction with expected completion in 2022 (Kaur, 2016). As can be seen in Figure 1.2 below, the KVMRT project timeline started from the railway scheme design up until the line completion. The entire duration of the project took about eight to ten years. Based on the limitation and scope of this study, it will only focus on the technology transfer that occurs during the project key implementation stage which consists of contract procurement and the construction phase of the KVMRT Line 1 and the Line 2 development phase. The justification for selecting this timeline period is due to the foreign and local contractors' active participation and also the high volume of works and cost involved during the procurement and construction stages (Burmistrov *et al.*, 2017). The involvement and participation of these local and foreign contractors during these stages will normally allow technology transfer to happen. Therefore, the main target respondents for the all the study stages are the personnel who directly participated in the KVMRT technology transfer programme either as participants or key personnel who manage and monitor the technology transfer process. However, for the reliability of the study, the respondents stated they have zero knowledge of technology transfer but have previously participated in a technology transfer programme in the questionnaire during primary study 2 would be accepted as a valid respondent to the study. The reason that this filtering question is in place in the questionnaire is to ensure only respondents actually have experience in technology transfer would be able to provide reliable feedback.

The procurement stage is an important area to study in terms of the pre-planning of a technology transfer programme before the construction stage starts. The construction stage is where the implementation and integration of the rail system occurs and where many of the rail systems are provided by foreign suppliers (Nee, 2013). Therefore, the construction stage offers a suitable platform and case study for developing the technology transfer model. However, the evidence whether technology transfer has occurred during the construction stage will also be examined and validated during the initial study stage. The targeted respondents consist of the staff from the civil contractors, sub-contractors, rail system contractors and consultants as well as the project owner and the project delivery partner for the KVMRT project that either participated in the KVMRT technology transfer programme or managed and monitored the technology transfer process. Due to the extensive nature of this project, most of the civil contractors involved are among the largest in Malaysia. Most of the rail system contractors involved in this project are linked to established global companies that have extensive experience in rail infrastructure projects (MRTC, 2013).

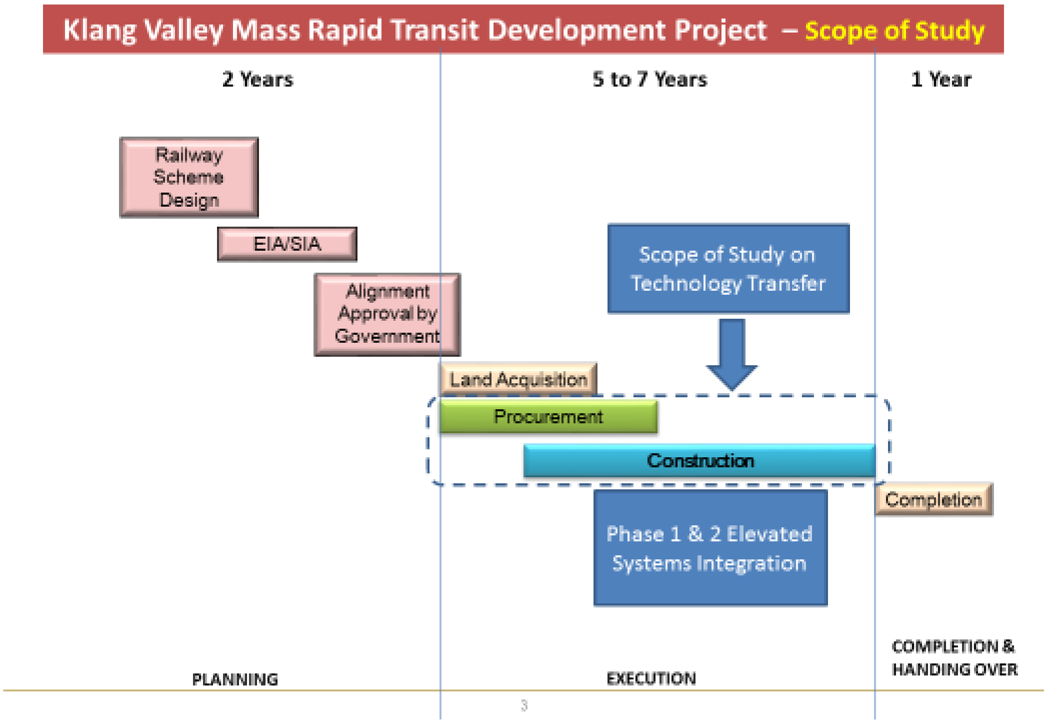

Figure 1.2 Scope of this Study

The selection of the KVMRT project as the case study for this research is also due to the government's mandatory requirement for a technology transfer programme stated in the tenders for the KVMRT project. The binding obligation imposed by the government provides an excellent platform for studying a technology transfer programme because all the selected contractors involved will have to establish one. However, at the same time, the obligation may create an artificial and closed technology transfer environment that is not driven by market needs. Therefore, a limitation of the study is the omission of market needs as an influencing factor. The developed Technology Transfer Model, however, should be able to enhance the effectiveness of technology transfer programmes in similar government development projects (Abdul Wahab *et al.*, 2012a; Waroonkun, 2007).

1.7 Research Stages

In order to achieve the research objectives outlined, the research methodology includes qualitative and quantitative methods, where each step is planned and conducted to achieve the study's objectives. As shown in Figure 1.3 below, the development of the KVMRT Technology Transfer Model consists of five milestones. The milestones are the development of the conceptual model, primary study 1, primary study 2, model validation and, finally, the findings and recommendations. Chapter 3 provides a detailed explanation of the research methods used for achieving the targeted milestones in all stages of the study.

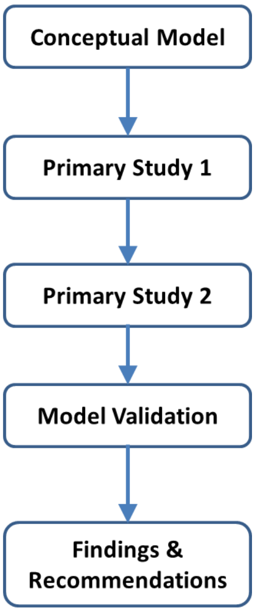

Figure 1.3 Research stages

1.7.1 Conceptual Model

In developing the conceptual model, an extensive literature review has been conducted to benchmark and analyse existing technology transfer models from previous studies. The study identifies the factors and sub-factors of the technology transfer process and their inter-relationships. Based on comparison analysis, a selected technology transfer model provided a suitable benchmarked TT model for the study. The detail of the technology transfer models and the development of the conceptual model are described in Chapter 2. The conceptual model serves as the basis for the further identification of factors and the relationships between them in later stages of this study.

1.7.2 Primary Study 1

Primary study 1 was conducted to test and evaluate the conceptual model developed during the early stage with the identified key experts. The key experts are filtered and selected based on specific criteria. One of the main criteria for selection as a respondent is that the personnel should be directly involved in managing or monitoring the KVMRT technology transfer programme. The filtering criteria ensure that primary study 1, which uses qualitative methods and tools, will receive reliable and high-quality feedback. The qualitative approach provides the study with potential new factors and sub-factors gathered from the key experts. The analysis and findings from primary study 1 are discussed in detail in Chapter 4.

1.7.3 Primary Study 2

Primary study 2 was conducted to test and evaluate further the findings from the primary study 1. The findings of the technology transfer factors and the relationship between the factors discovered during primary study 1 were then analysed quantitatively during the primary study 2 stage. Primary study 2 uses a questionnaire approach to gather feedback and data. About 435 questionnaires were distributed to participants in the technology and knowledge transfer programme in the KVMRT project. About 306 survey forms were returned of which 104 were rejected. Finally, the data provided by 202 respondents were subjected to quantitative analysis using descriptive statistics, factor analysis and Structural Equation Modelling (SEM).

1.7.4 Model Validation

The validation stage was conducted with the main objective of validating the technology transfer model developed in the primary study stage. The methods used in this stage were a focus group and case studies. The focus group membership consisted of participants from the relevant organisations responsible for the KVMRT technology transfer programme. The findings from the focus group also helped in fine-tuning the KVMRT technology transfer model. The case study approach is one of the primary methods for validating the developed technology transfer model. Five case studies were chosen as the platform for validating the technology transfer model. The data from these case studies were collected through interviews and the content analysis of related documents.

1.7.5 Findings and Recommendations

The final findings were prepared once the technology transfer model had been developed and validated for all the study stages. The recommendations made are for future similar projects that want to implement an effective technology transfer programme. The recommendations can be used by project owners to plan, develop and manage an effective technology transfer programme where the outcomes can be measured. The findings from the study can be used as a reference and guide for future research on technology transfer models and technology transfer processes used in large public projects, especially in rail infrastructure projects.

1.8 Thesis Structure

Below is a summary of each chapter and its purpose ranging from describing the research methodology, planning the study, the research implementation and the study findings.

Chapter 1 provides an introduction and background to the study. The chapter will provide the basis on the need for study and explain in detail its background. In the chapter, the objectives of the study are explained and how it will achieve the intended objectives. The chapter will also provide the problem statement of the study, its scope, the research stages and the thesis layout.

Chapter 2 provides a literature review for the study. The literature review covers previous studies related to a technology transfer process, technology management and technology transfer models. It covers the analysis of the literature covering technology transfer models and factors related to the technology transfer process. It also covers the types of technology transfer model and the evolution of government policy influencing the technology transfer model in Malaysia. The KVMRT conceptual model will also be developed in this chapter based on comparison analysis of selected technology transfer models found in previous studies and research.

Chapter 3 provides the details of the research methodology used to achieve the objectives of the study. The chapter will explain the data-gathering methods used for the study. It also outlines the research tools and analyses used for the conceptual model, primary study 1, primary study 2 and model validation stages.

Chapter 4 provides the results and analysis of the primary study 1 and primary study 2 stages. The results consist of the data gathered during the interview stage and the distribution of the questionnaire stage. It also explains the steps described and the justification for the analysis tools. Chapter 4 also provides details on the validation of the technology transfer model developed from primary study 1 and primary study 2. Gap analysis is also conducted in this chapter to meet the intended objectives of the study. The explanation in this chapter includes the validation methods and the result of the validation analysis.

Chapter 5 provides the findings and discussion of the results and analyses in Chapter 4. The chapter explains in detail the key findings and recommendations that can be adopted by similar future rail infrastructure projects to develop a successful technology transfer programme. The chapter also provides the findings from the gap analysis and the recommendations made to close these gaps.

Chapter 6 provides the conclusion and recommendations for the study. The conclusion includes a summary of the results and findings regarding the study's objectives. Recommendations for future research, as well as the limitations of the study are also explained in detail.

The questionnaire form used for the primary study 1 and the transcribed answers are attached in Appendix A and Appendix B.

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Appendix A Question Form (Primary Study 1)

TECHNOLOGY TRANSFER MODEL FOR THE KVMRT LINE 1: SG BULOH TO KAJANG

INDUCTION INTERVIEW QUESTIONS

NAME OF INTERVIEWEE :

POSITION :

YEARS EXPERIENCE IN TT PROCESS :

NO.	QUESTIONS	ANSWERS
1.	**CONCEPTIONS OF TECHNOLOGY**	
A.	What are the agency's requirements or objectives for Technology Transfer?	
B.	What are the strategy or initiatives used by the agency to identify the requirements for Technology Transfer?	
C.	What are the current Technology Transfer Programme or mechanism used?	
2.	**TECHNOLOGICAL ACTIVITY AND TT TRANSFER**	

A.	Please explain the agency's process in terms of planning for Technology Transfer Program/Projects?	
B.	Do you put any proper mechanism to monitor the activities?	
3.	**COMMUNICATION CHANNELS**	
A.	What are the current communication channels for Technology Transfer process and activities?	
B.	Does the communication channels effective and understood by all the related stakeholders?	
C.	If not, what are the improvement you can suggest to improve the communication channels?	
4.	**MODES OF TECHNOLOGY TRANSFER**	
A.	What are the available Modes of Technology Transfer in the agency?	

B.	What are the most used modes of Technology Transfer?	
C.	Which modes in your opinion is the most effective?	
5.	**IMPACTS/RESULTS OF TECHNOLOGY TRANSFER**	
A.	What do you consider as the criteria for the results of Technology Transfer in the project?	
B.	What are the measurement used by the agency to measure Technology Transfer results?	
C.	What are the innovation resulted from the Technology Transfer process?	
6.	**GAPS IN THE TECHNOLOGY TRANSFER PROCESS**	

A.	What are the Lessons Learned from the previous technology transfer process?	
B.	What are further improvement that you can suggest to technology transfer process that have been implemented?	
7.	**FACTORS AFFECTING TECHNOLOGY TRANSFER**	
A.	**Does this factor affects?**	

1	**2**	**3**	**4**	**5**
Very Low	Low	Moderate	High	Very High

Transfer Environment

- Complexity of Technology = _______
- Construction Modee.g.eg. JV vs Sub-contracting) =________
- Organization Policy =______
- Government Policy =______
- Government Enforcement =_______

Learning Environment

- Relationship between WPCs and Recipients =_______
- Mutual Trust =_______

- Clear Understanding of the scope of technology transfer =______
- Effective communication =_______
- Strong commitment from senior management of WPCs and Recipients =______
- Teamwork =_______
- Supervision =_______

WPCs Characteristics

- Willingness to implement =_______
- Degree of Experience =________
- Appropriate Management practices and approaches =________

Recipient's Characteristics

- Willingness to learn =________
- Experience working with Foreigners =________
- Appropriate Management practices and approaches =_______
- Adequate knowledge base = _______

Outcomes of TT

Economic Advancement

- Firms competitiveness in the market =________
- Firms overall performance (e.g. better management, better quality) =________
- Firms overall profitability =________

Knowledge Advancement

- Improve workers knowledge and skill =________
- Enhance their working practices =________
- Improve firm's skill base over the long term =________

	- Increase the innovation in the firm =_________ **Project Performance** - Enhanced the project financial performance (e.g. project budget, cashflow) =________ - Enhanced schedule performance (e.g. on time completion, resource planning) =________ - Enhanced the project quality standards (e.g. less re-work, improved deliverables) =________	
B.	Can you propose any other Factors affecting Technology Transfer for the organization?	

Appendix B Transcribed Interviews (Primary Study 1)

EXPERT INTERVIEWEE CONSENT FORM (TEMPLATE)

Title of Project :

Model of Technology Transfer in the Klang Valley Mass Rapid Transit Project

Name of Researcher :

Abdul Rahman Hamdan

Contact of Researcher:

Email :

H/P :

Statements	Please tick where appropriate	
	Yes	No
I have read the transcribed sheet from my interview session for the above research and acknowledge it is true		
I agree to take part in the research process as a respondent for the study		
I understand that my participation in this research is voluntary		

Name of Expert Interviewee:

[Name of Expert]

[Position in the Company]

I hereby agree to take part in this research

Signature :________________________

Date :________________________

Research Supervisor

Dr Mohamad Syazli Bin Fathi

Universiti Teknologi Malaysia

Razak School of Engineering and Business Management

Respondent A1

Have to see in which angle you see. We have system, civil and design and build. Which angle are you looking. If you consider this as construction phase, the technology transfer more towards system and underground. Technology transfer for underground happens even during preliminary design stage. For the Tunnel Boring Machine design, the technology transfer is during the concept design itself. I would say most technology transfer happens during the manufacturing phase. During design stage we do sent people to Thailand for Signalling system and China for Electric Train to learn but most of the Technology Transfer happens during manufacturing. Detail design I don't think so because most of the design is proprietary. It is more to the commitment by the WPC. The TT is dependent on WPC and Recipient.

In terms of objective, MRT follows the Offset Requirement Document (ORD) set by the government for the technology transfer. But, MRT is committed to comply regardless not have to follow the ORD. We don't get fund from government. No internal objectives. MRT use the ORD as the guideline. MRT have offset programme, Bumiputera mentoring programme.

Planning for TT depends on the schedule A set in the ICP programme. We appoint dedicated consultant to monitor. We have the ICP Committee Meeting every quarterly as well as the working committee to monitor the TT programme.

In terms of communication channel, procurement is playing the lead and we will coordinate with the technical, HR or etc. Centre point and reporting by procurement. System team will brainstorm on what project they want to do and procurement will facilitate. You have training, OJT so each unit do their own thing, but procurement consolidate. HR is more to resource planning and appointment of new staff.

The communication mechanism is effective. Will improve better with no intervention from external parties. We should have the benefit of having our own staff to benefit but due to external parties, other people are benefiting so the benefit is loss.

Classroom, OJT, overseas training. Classroom mode is the most used. The most effective is On-the-job training. OJT is the best but you cannot accommodate all. There is limitation to participants.

Criteria for a result of TT is job enhancement and knowledge enhancement. Some of the trainee went to join the operator. So, it is more to career progression and improvement. Other than that no. Another criteria can be publication from universities based on data shared to them.

The measurement for TT is that they are marketable and employability. Improvement to their salary. They should be better planning for the programme. Initial planning is a bit of shame. In other things, MRT always plan from the beginning. Unfortunately for the Technology Transfer programme, there is no planning at the beginning as no one knows the best way to do this. We know the gap industry have and what we can commit to serve. I wish we have thought this programme properly so that it can meet industry's need. The planning should have a common ground so that the recipient involved can contribute back. MRT, industry players and operator should have contributed to the IRD at the very beginning. That one is lacking. If you look at the IRD and ISD document, it is still very general and you do not know what to do still. By right, it should be more specific, for example, for signalling, how many signalling engineers you want to develop as we are lacking signalling engineers. We still depend on the expatriates. In terms of technology, manpower and resources they should have identified during the planning.

The planning we do currently is based on the proposed schedule A in which is from WPC. So, we are dependent on what WPC are telling us instead of us telling them what to do. The consultant should be more intelligent proactive and give more specific. The IRD should have been a consolidated effort between the government agencies, regulatory body, industries and the operators. This is still lacking. Think tank is not there. Factor that can be included that is not here is third party interference.

Respondent A2

All the trainees for the offset programme in Line 1 has been absorbed for Line, 2. All have been employed by MRT. For MRT requirement, technology transfer related to technical team, so we request Head of Department of respective Systems team what are the requirements such as at what level, what subject and scope. We have that session requesting them the requirements. The offset requirement document given by the government is only for the tender stage. Once a contractor selected, the WPC's technology transfer proposal then is the aligned with MRT's policy and direction. Example, does the company allow to take new fresh graduate for the technology transfer programme or not. And then what is the career path for this graduates, where are putting them after this. Or maybe, we just want to enhance the existing staff capability that already here at MRT.

This direction can be determined by the project team and also aligned to HR. HR also has their own strategy and career path plan for the staff. Regardless if there is an offset or not, our internal HR already have technology transfer plan based on the expatriates that we hired. They have to share their knowledge to local MRT staff. One way formal channel is through presentation. We invite any staff interested to attend the presentation by this expatriates. So, HR encourage the expatriates to transfer their knowledge to MRT local staff.

Other ways of technology transfer is the local staff is working under this expatriates. These local staff will be exposed to the way how this expatriates work and that is considered as technology transfer itself. It is like a mentor-mentee programme. It is not a structured programme.

In terms of OJT and presentation channel, most effective is the OJT. Presentation is too wide and general. They only explain the history, what type of technology available and not that specific. But with OJT, you can have troubleshooting problems and they can learn that on site. OJT is better.

The main technology transfer channel for MRT is the offset programme and the expatriate's knowledge transfer programme. In terms of planning for technology transfer, I think the rail system technology is very niche and specialised knowledge. If HR try to recruit locally but no available local talent, HR will try to find foreign. So, the strategy of HR is mainly to fill the gap for delivering the project.

In my opinion, if MRT really serious in replacing the expatriates someday with the local, the expatriates should act as the advisor only and not put them as director. Example, put local people as tunnel director and the expatriate act as advisor to the director. This expatriate will train this local to be competent as him. This way they will actually be taking the responsibility and doing the job. But the problem is that MRT project is a fast track and we don't want to take risk for the project. The limitation is time. This thing cannot be a trial and error. If we take local and try to train but we cannot compromise the project.

If we talking proper monitoring is the consultant MRT appointed, the ICP Management Unit. The MRT project team needs to monitor the project. The monitoring committee is the MIEC, IWC.

Because of offset, we have meeting and progress update. There is a structured approach. Communication is through progress meeting and committee. It should be effective. Cannot think any other effective platform besides that project management.
To improve, must have working group involving the HR, project team and procurement itself. Act as interfacing meeting. PDP also can get involved. It can be better.

Difference between Line 1 and Line 2 is that only selected packages are selected for technology transfer. So, we missed certain packages that should have technology transfer. For Line, 2, it is different as we based on certain value.

Mode of technology transfer is classroom, OJT, mentor-mentee, knowledge sharing via presentation with small group and large group. For example I went to over sea, when I get back I have a knowledge sharing session with my colleague on what I learned.
The most used technology transfer channel is OJT. The most effective is OJT. Due to hands on. Trouble shoot and problem solving real problems.

Result of the technology transfer is developing engineer in terms of competency and exposure from the real project. For instance, there is no signalling engineer before. Now, the engineer is specialised to a new field. There is also salary increase and promotion. Before trainee and now become engineers.

There might be difference compared to graduates who did not go for the technology transfer programme and graduates who participate in the programme. Because the graduates is now highly specialised. The graduates who participated in the technology transfer is reliable as they have undergo a steep learning curve.

The measurement used to measure the competency of the engineers is through yearly performance appraisal and also half year review.

In terms of innovation, there is not much can be seen. Offset is something new. Maybe not in Line 1. But maybe long term we can only see innovation. In order for innovation to happen, they must have personnel that is very experienced and good knowledge. Human resource is important and normally small companies cannot afford to hire expertise for long term. If you want to do R&D, the cost is high but the return is very minimal in the short term. So, if you are a small company you do not have the funding to do R&D based on the offset programme. Only big companies can afford to do R&D because they have big pockets.

The offset trainee is much more versatile. Trainee from ET not necessary work in ET package. They can work under COMMS package and they able to adapt.

Lessons learned from Line 1, planning and actual thing might be different. For example, MRT supposed to be the operator but that did not happen. Now we know we could not take many staff. Another, if IMU wants to be as the champion for the national roadmap, they should make known to other stakeholders like MRT and Prasarana on what are their objectives and target. The target is not clear. They want to develop human capital or local industry? That is not clear. It is either they have a detail roadmap but not make known to us or the current roadmap is too general. They must make it more specific. When too broad, you will try to do everything so you cannot focus. For example, MRT you need to focus on this, Prasarana you need to focus on this, so that we can achieve more and not duplicating.

Another improvement is that Malaysia needs to see the technology transfer success stories such as foreign signalling companies in Bangkok. Even without offset they can collaborate with universities. Maybe there is incentive for them to do technology transfer programme. So, this company are willing to transfer technology. It is a win-win for them. They do not need bring in expatriates as they can employ local and they can get business from that country. It should be on a win-win situation. Attract foreign investment and train local. Now, in Malaysia it is only project based. Once, project finished than they left. Foreign signalling companies can set a base in Bangkok for long term. The government agency is the one should be leading this and MRT will follow.

Another factor needs to be included is the rail academy. Established higher learning specific for rail support industry. It is the learning infrastructure for technology MRT. This includes having trainers and lecturers. This can accelerate the technology transfer, more structured and can be more innovative.

Respondent A3

The effectiveness is when the young engineers is attached to the real environment, working alongside the engineers who is doing the actual work. They got not only theory but also hands-on practical. Not all knowledge can be transferred in classroom. Some of the knowledge they can pick up during OJT. More effective if during attachment, the WPC actually give real jobs to the trainees. Trainees to assist WPC indirectly the trainees will benefit more. I remember one trainee attached at Bombardier office doing interface CSD and SEM drawings. Even though they are using the trainees to do the review, in the same time the trainee can learn.

A good attachment if we give the attachment 100 percent to the WPC. The WPC take care of the trainees. They treat the trainees as a staff so they will train the trainees to do their work. They will make sure the trainees do their work properly so the trainees will learn better. If the trainees are attached at MRT it will not be that effective.

During Putra LRT, it is different concept. When I joined as an engineer, the direct OEM provide the training. For example the auxiliary power unit, the supplier is a British OEM, they provide the training. It is classroom plus OJT.

The planning of technology transfer is based on the Offset Requirement Document, in which MRT did provide some input to it. The input is from MRT. How many engineers and how long. If there is no ORD, we follow the contract. Under the contract, WPC needs to conduct train the trainer programme and training. The project team set the training requirements in the contract.

In contract deliverables, the training is for the operator and maintenance can maintain the system once WPC handover. OEM do the training just for maintenance and operation. When come to Offset, we should ask more from WPC. Under contract deliverables, they provide level 1 and level, 2 training. But under Offset, we can request up to level 3 maintenance training. So, far we have never capture knowledge during design stage. Only the design is ready, the training is provided. However with Offset, we can have knowledge transfer during design.

Mechanism used for TT is Offset programme and contract deliverables. We plan based on my past experience in Kelana Jaya Line, we know how many engineers required to perform maintenance.

In Offset, we monitor through the consultant appointed. For contract deliverable, we have proper record and evaluation form. The communication channel is ok because we have the MRT IC Committee and the working committee.

Line 1, we do interview. We appointed panel for evaluation including HR and project team. Project team decides the requirement and HR will plan the resources.

One improvement I can suggest is how to measure the competency of the participant. Need proper mechanism. Supposed to be led by HR or by the consultant, IMU. Based on Line 1, the competency is proposed by WPC so there is no standard guideline on the competency level need to be reached. How to measure the effectiveness of the project. Does the participant really receive the knowledge? IMU currently only monitor the progress.

Collectively, the level of competency should be agreed by all. Mode of TT – OJT, Classroom. Offset engineers is involved in testing and commissioning. The real implementation. They are now independent and no longer OJT. For signalling, we assign them to do reports/assignment. Mostly used – OJT and Classroom. Most effective – OJT. Criteria result – Competency.

Currently there is no proper competency measurement. In real world, they can now work independently no need supervision anymore. How do measure the result - Observation and Yearly performance job appraisal. However, this measurement should only be done by project team.

No innovation but only competent engineers. They can review design documents.

Lesson learned we must thoroughly review proposal by WPC. Training module by WPC. Otherwise we only received basic technology transfer. In Line 1, due to short time. WE leave it to WPC. For Line, 2, we propose WPC to propose earlier. We want more advanced technology transfer. Also another lessons learned, we do not need many participants so that the programme can be more effective. We need to consider WPC limitation such as space, trainer availability, facilities. For signalling is only 4 staff attachment and their scope of TT is clear. We attached them to a specific area. WPC can train them one-on-one.

I suggest for the TT, we should give to experience engineer as well. For fresh graduates, WPC only give basic TT. But if we want enhanced technology, we must give them experience engineer more than 5 years.

The place for technology transfer is very important. WPC needs to provide the facilities for effective TT.

Respondent A4

During design, our staff is also attached to WPC. Technology transfer happens mostly in construction phase that includes design. Technology transfer has many categories of transfer. Most transfer is effective. For example, in the case of MRT project, the WPC appointed a local company as offset recipient. So, these people in the local company is already involved in preliminary design. The highest technology transfer happens during detail design. Construction is where they implement it.

There are sometimes the provider are keen to transfer but the recipient are not ready. For example like this local company where they are not serious and take it lightly. Other reason is the local recipient do not have sufficient people. Some of the local recipient use the programme as just to get them jobs instead of using it to develop them.

The technology transfer can happen in a meeting, sometimes in a classroom or sometimes in a form of On Job Training (OJT). The commitment to TT must be equally between Provider and recipient. For example, like one of the local recipient, they are eager for the transfer, it has been a win-win situation for both parties. As for the technology transfer environment, if the recipient are eager for technology transfer, they themselves would create that environment, for example, they organize workshop, they go to Japan, send their people, that shows that they are committed. Because technology transfer environment is subjective, but if both are committed, the right environment will happen.

There government policy has no effect to the learning environment. It is up to the WPC and recipient to set the learning environment. Government policy is not a factor influencing the learning environment. The government policy is there only to make sure the WPC under their offset obligation. The key factor is still on the commitment from WPC and recipient. The government policy is more to a guideline and it is not a critical factor. They only need to fulfil the offset credit value. But successful is still subjective. It depends on the interpretation of both WPC and recipients.

Our technology transfer objective is more to know-how and technical knowledge. We are consider new company we need people to manage the project well. In the railway market, is always a shortage and we have no choice to train our own people. So, we identify which is the area as a gap and we put people to train there. For Line 1, the objective is more to human capital development. We employ more than 30 to 40 of young engineers to go for the offset project. The objective of the technology transfer is actually defined together with MIGHT at that time. MIGHT already have the Gap analysis and rail blueprint. As a complement to that to look at area MRT requires for technology transfer especially knowledge transfer. If you look what relates to MRT is more to knowledge transfer. But if you look at the KVMRT TT programme, it is more to the industry requirement. During tender stage, I did asked whether MIGHT perform any gap analysis. So, we use the blueprint as a guide.

The mechanism for TT are Offset and OJT. People who are not in the offset programme use OJT as a mean to get the knowledge transfer from contractor.

OJT is planned during the construction period. We plan the placement people according to the progress of the project from preliminary design, detail design, construction, installation and testing. Even without offset we will do that.

This staff needs to give weekly report and from there we gauge on how much knowledge they have acquire in that particular session. If they attach during detail design, the technology provider will provide the assessment. It is done weekly and based on that, WPC as the technology provider will submit a report to MRT.

We engage HR as well, we call all the staff who is involved in the offset programme and they present what they learn. Three department is involved, procurement, project team and HR. HR is interested in the development of the people and how we run the training and the knowledge acquired. Both HR and project team set the requirement. HR have its own KPI for their training. Area for development is set by project team. We say this is the gap and this is the area this engineers to be train to. In terms of successfulness, the project team will decide whether the knowledge transfer is successful or not. Project team understand more on the technical part of this. All of the parties understand their role. Procurement is more to the management aspect of it. Offset project is handled by the MRT procurement. But the actual beneficiaries are the project team.
Improvement to the communication.

Improvement in terms of communication, when we started, not many people knew the objectives of the programme. Towards the end of the programme people now understand. To gauge its success or failure is very objective. When the people go on Line 2 we can know whether they are successful or not. These engineers involved from design to construction and they come from zero experience in rail. Now they can even give feedback and input back to their knowledge provider. Advantage to people who involved in Offset is the experience gained.

Types of TT are Classroom, OJT. They get involved in the design process, e.g. Comment on the document. They get to be involved in the process even though at that time they do not know the right answer. They have to read, discuss and through meetings they know the answer and the technical terms.

They did a simulation study at Japan that includes FAT also. Other channel is self-learning. Example, here they learn 750 DC for MRT. But to be good engineer, they need to know other systems. So, they are asked to go visit ERL, KTM, Ampang Line. So what are the difference and what are the similarities. They need to know the reasoning on why KTM using this system, why ERL using this system.

The most effective channel is OJT. For me the result of TT is for the engineer to know the system and for them to challenge it. They are able to have critical thinking and they can argue. They can argue with the designer on why it is done like this. In terms of MRT, better manage their project, better quality system. This engineers are exposed to overseas practices and they can propose the best system.

Currently there is no exact measurement for TT. In terms of during assessment, we have questions and answer. Similar like exam. The actual how much they absorb we cannot quantify at the moment. But it is useful for them to be able to comment for the next project. Do system improvement. Performance appraisal can also be used as measurement tool also.

Some of the lessons learned is that the recipient must be ready. Don't use this opportunity of TT as a way to get a job. They supposed to take it positively. Probably it is against the norm what they normally do for a project. They need to improve. If they do not have sufficient manpower, they need to get the manpower for the TT. That is in terms of product technology transfer but in terms of training, actually the recipient itself plays the important role. If the trainee is lazy and do not want to learn, do not want to be involved, how much they can grasp. This is very much on the trainee, how much they can grasp the knowledge. Attitude of the recipient is important. When we hire this people, we choose them carefully. They are the chosen one. If they have attitude problem, the programme will fail.

In terms of improvement to TT programme, from management point of view, we need to clearly identify the gap and the industry requirement. MRT and also the government body such as MIGHT and TDA. There a lot of rail project, it is a waste if we do not capitalize. Training and human capital development, human capital development now more focus on enhancing junior engineer. How about the senior engineer? Middle and upper engineer. They still hire foreigner for this position. We need a programme for the middle one. For Line, 2, we do not want to focus on junior engineer. We are targeting development for intermediate and advanced course. Line 1 is more entry / basic course, they now have experience and we targeting for advanced course. Now, there is no clear programme how we can replace the expatriate. This should be at MRT and TDA level. Not just MRT but around the world have a shortage in rail expertise. rail support industry is a government led industry. The more complex the less effective the technology transfer.

Joint-Venture is much more effective as they will do it together and that is more effective. Is enforcement an important factor? It can be an effective tool to force WPC to transfer technology. Senior management commitment to the programme is very important.

Look at category of TT. If HCD, the knowledge that they received is already a reward. Training itself is a reward to the recipient. You need to put category to the TT. Category in terms of human capital development or training. Another category is product knowhow. If you want to assist and develop new product. The assessment is different. You cannot use the same measurement for different type of TT. If you can separate that you can have more accurate data.

If HCD, OJT is more effective. But product development, JV is more effective. In power offset, both types of TT is there. The local recipient in the KVMRT power supply package is ok because they have experience, good relationship and trust with the technology provider. All the factors plays an important role. For some of the local recipient, they burned the trust and relationship with their technology provider and that is why it is a problem. Criteria mentioned here does happen in actual MRT TT programme.

Respondent A5

There concept design first before preliminary design. TT happens mostly during construction. If we look at ET package, during detailed design they decide on the suppliers. If we look at construction, the TT is not that significant because the suppliers use their own technology. If the design by WPC and advised by WPC is ok, but for the project is only business arrangement. In the local assembly plant, there is TT in the process of assembly. Installation and testing & commissioning there is TT. The knowledge transfer is not much during construction due to the WPC's business policy. There is limitation. If we look at the TT, there is no new technology that is transferred. For example, the case of Boogie, it is one of their core business. So, there is no TT for that area. For Malaysian local companies, if we were to invest in the infrastructure for Boogie, the volume is not there. There is high requirement in the MRT project so it is not worth it for local companies to invest due to the small volumes.

The planning and requirement for TT is based on the ORD. MRT follows the guidelines in the ORD. If there is no ORD, MRT do not have any clear policy on TT.
Mechanism used is ORD and Offset programme. In MRT itself we try to leverage on the expatriate. What HR did is organize knowledge sharing session with the expatriate working in the project from MRT, ICE and PDP. Classroom and also working together with the expatriates.

In Offset, we follow the Offset programme. Internal process, with expatriates we plan the knowledge sharing once a month. In terms of monitoring, we have two times a year we evaluate our MRT staff recipients together with technology provider. We interview, record and give assignment. We also do rotation system to the staff.

In terms of communication channel, all the recipients report to WPC and WPC's JV. We have also monthly meeting with WPCs. The communication channel is moderate. Improvement that can be done, the problem is they put under JV. It should be put direct under the WPC. The recipients receive two instructions from WPC and WPC's JV partner. Only one side monitor the recipients.

Modes of TT – OJT, Knowledge sharing, process development, test equipment, testing, Modes most used – OJT. Effectiveness – Human capital is OJT.

Criteria of result – Weakness of the programme is that it is not properly planned. The recipients are fresh graduates and only exposed to assembly work. It is good if they are exposed to operation and testing. They should attach them with other project not just at MRT project. They should focus on operation and testing. Result and competency is in specialized areas.

Measurement – Measure through the two times a year evaluation meeting. In terms of result, not necessary on knowledge, it is also on communication, working experience. Some of the programme such as the signalling package, the result is good. But not much with other WPC.

No innovation occurs from Technology transfer due to them only exposed to assembly process only.

Lessons learned, the programme should be plan properly. What is the objective and how to achieve the objective must be clear. The plan for them to be subject matter expert but that does not happen.

Who should the lead or driver for the TT to achieved the objectives? The IMU should take the lead because the ORD is prepared by them so they must make sure the programme achieve the objectives set in the ORD. Each parties need to be clear on what their role. Objectives must be clear and in line with the Job OJT. There is misalignment between the objectives and the job OJT set to the recipients. We prefer placement with the OEMs. Another lessons learned, the recipients should have one or two years' experience. So they would know what knowledge to absorb and what questions to ask. The transfer did not happen because the recipients did not know what to ask. They even do not know the technology is new or not. If the WPC is cooperative, the recipient should also be from people that have more experience for more effective technology transfer.

Respondent A6

There is no requirement of TT in MRT. Solely depending on ORD. Current mechanism for TT is Offset programme. Besides offset, not much TT programme.

We transfer staff from line 1 to line, 2. We also have lessons learned workshop. We shared what is good and what is bad during the workshop. So, there is knowledge transfer happened.

Project team do the planning for the lessons learned workshop and the TT programme. In terms of monitoring, we come up with the outcome of the lessons learned we put it in the tender requirement for line, 2. Monitoring is done through project management such as project meeting.

From communication, technical requirement comes from project but if it concerns policy it relates back to procurement and HR.

Any improvement to the communication, depend on the personnel in the project team. If the personnel is very active and interested in the offset programme, there should not be any problem in terms of the communication.

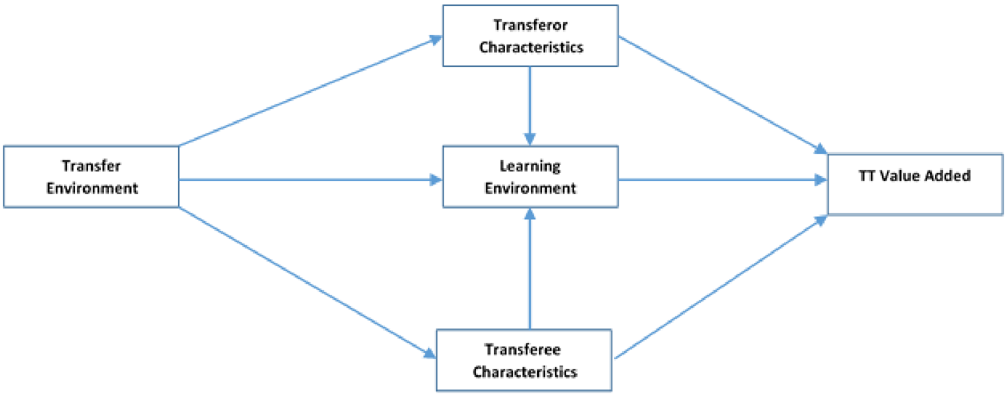
Procurement just playing coordinating role and liaising between TDA and project team. Procurement should be there but the project team should be leading in terms of developing the TT programme. Procurement as coordinating role is effective currently. MRT channel for TT are Technology Transfer programme, knowledge sharing – classroom type, once a month.

In terms of knowledge transfer of WPC to MRT is more to OJT and on-site learning. Main mode used are OJT and on-site learning. The most effective TT are OJT and on-site learning. Knowledge sharing (Lessons Learned) is effective or not? We can know what happen in Line 1. We try to avoid in happening in Line, 2.

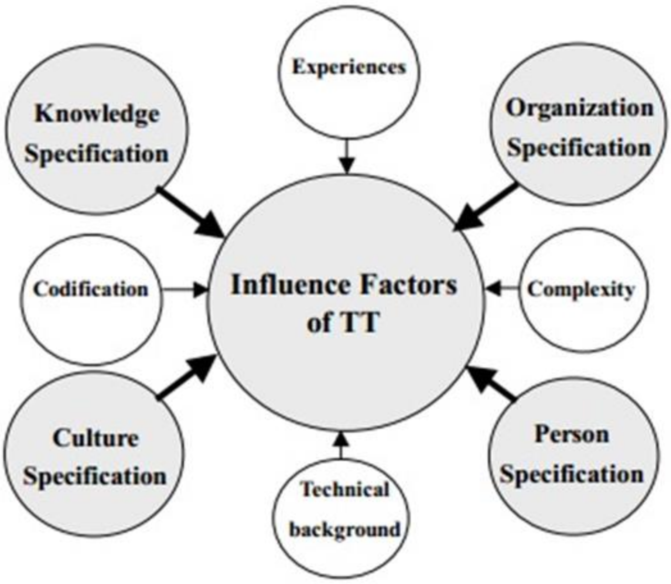
TT criteria for a result can be improvement of knowledge from our MRT staff. Increase of competency. Measurement is more on job performance on whether they can manage the suppliers better. For example, the trainee from Offset they are better performing in the job. Job performance appraisal is used to measure. There is also increase of salary and promotion.

In terms of innovation, not much I can see. Lessons learned, the technology transfer should focus more on the design and interface. Not much on construction. Improvement we can get more people to be involved in the design. Most Malaysian involved in construction but not much during the design phase. For track work, it should focus on design not much on construction.

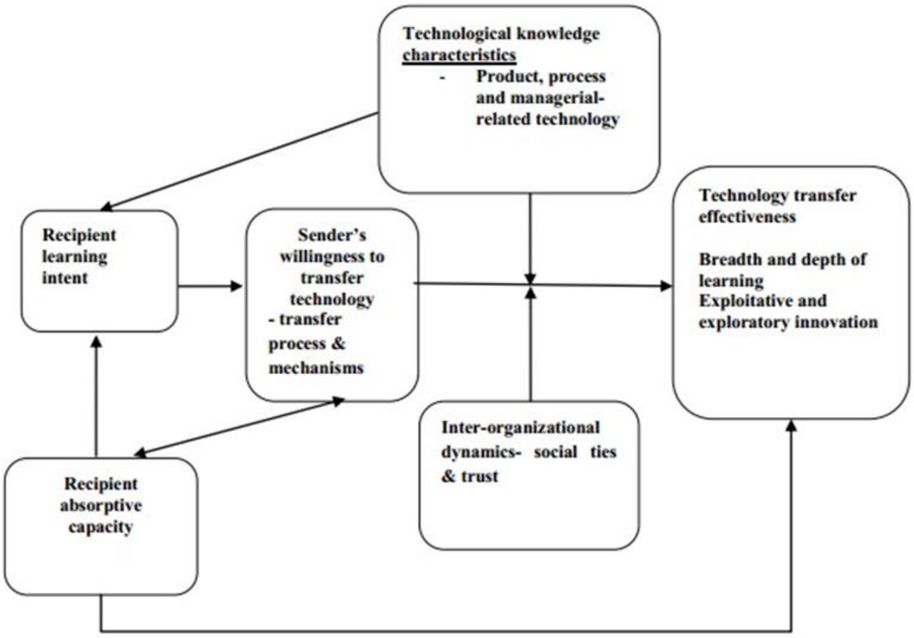
Appendix C TT Models from the Literature Review



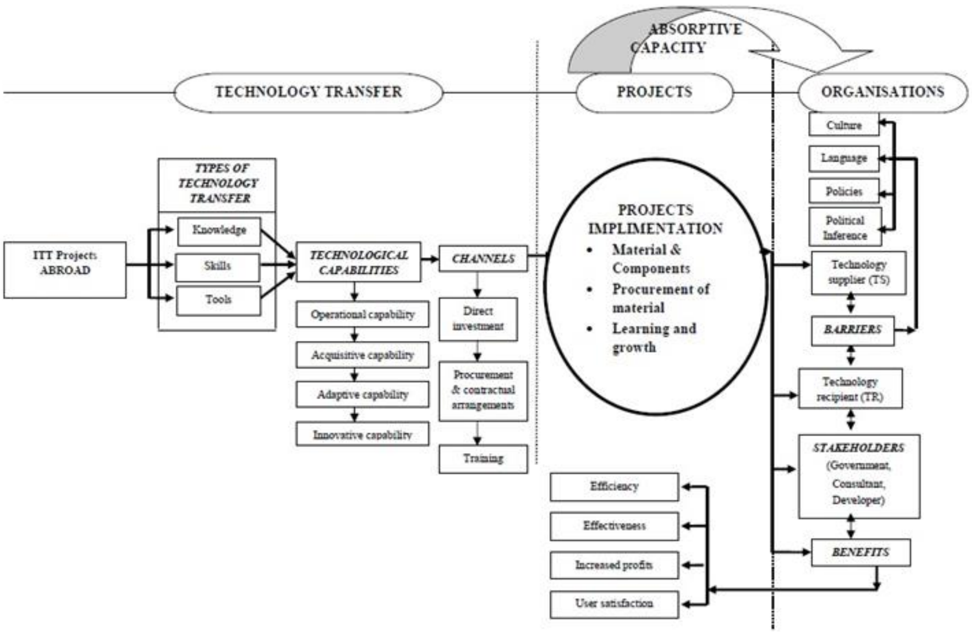
Conceptual model for international TT in construction projects (Waroonkun, 2007)



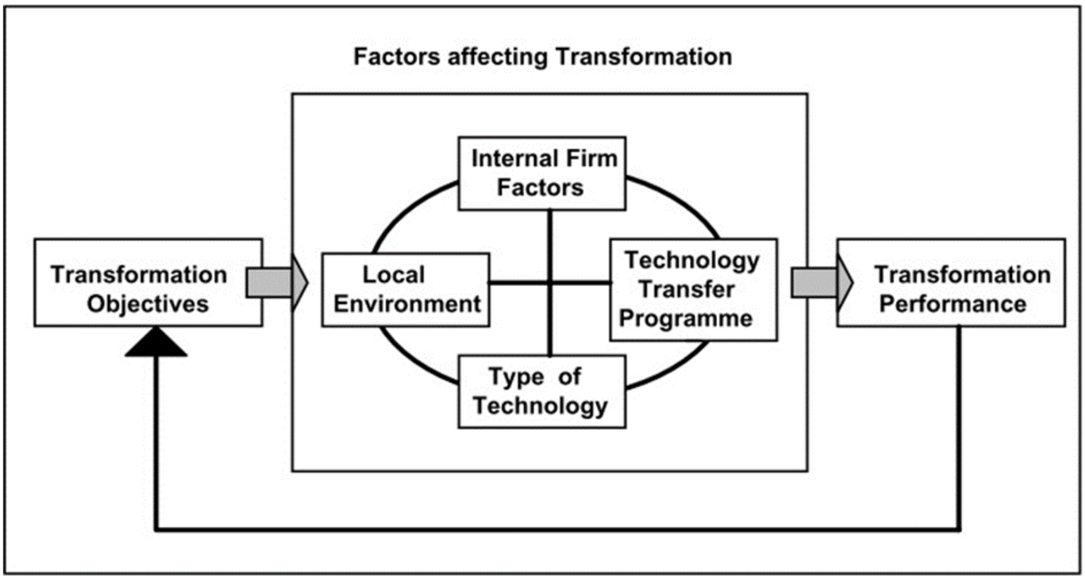
Influence Factors of Technology Transfer (Lai and Chao, 2006)



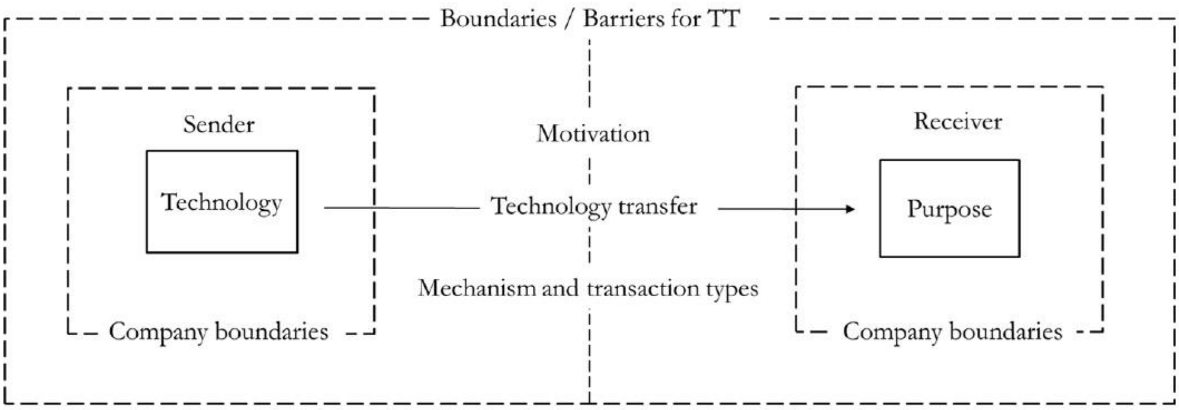
TT Conceptual Framework (A. Khan, 2011)



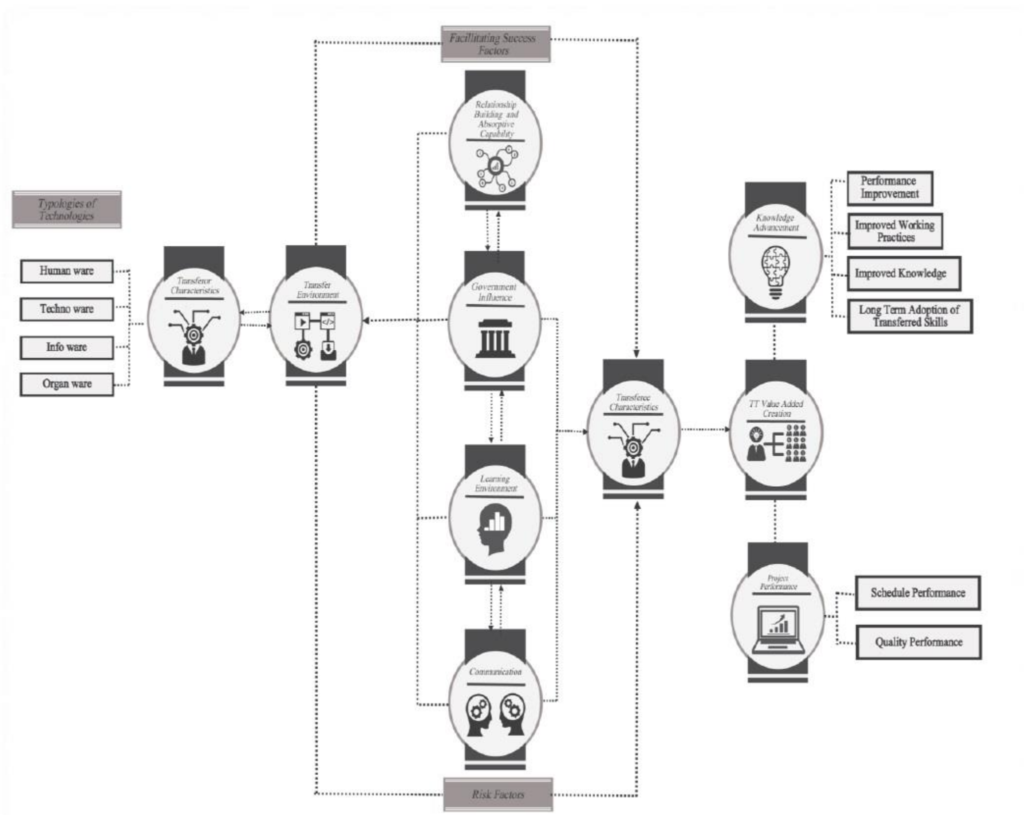
Amalgamated Model of International Technology Transfer Project Models in Malaysia (Omar *et al.*, 2008)



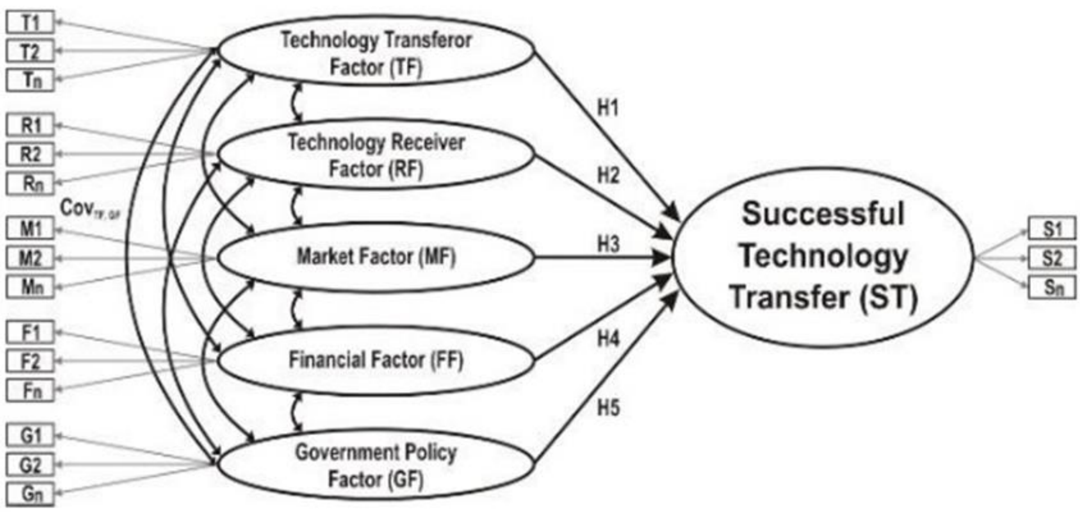
Capacity and Capability Development in Indigenous Construction Firms through Technology Transfer in Construction: A Malaysia Experience (A. Bakar, 2006)



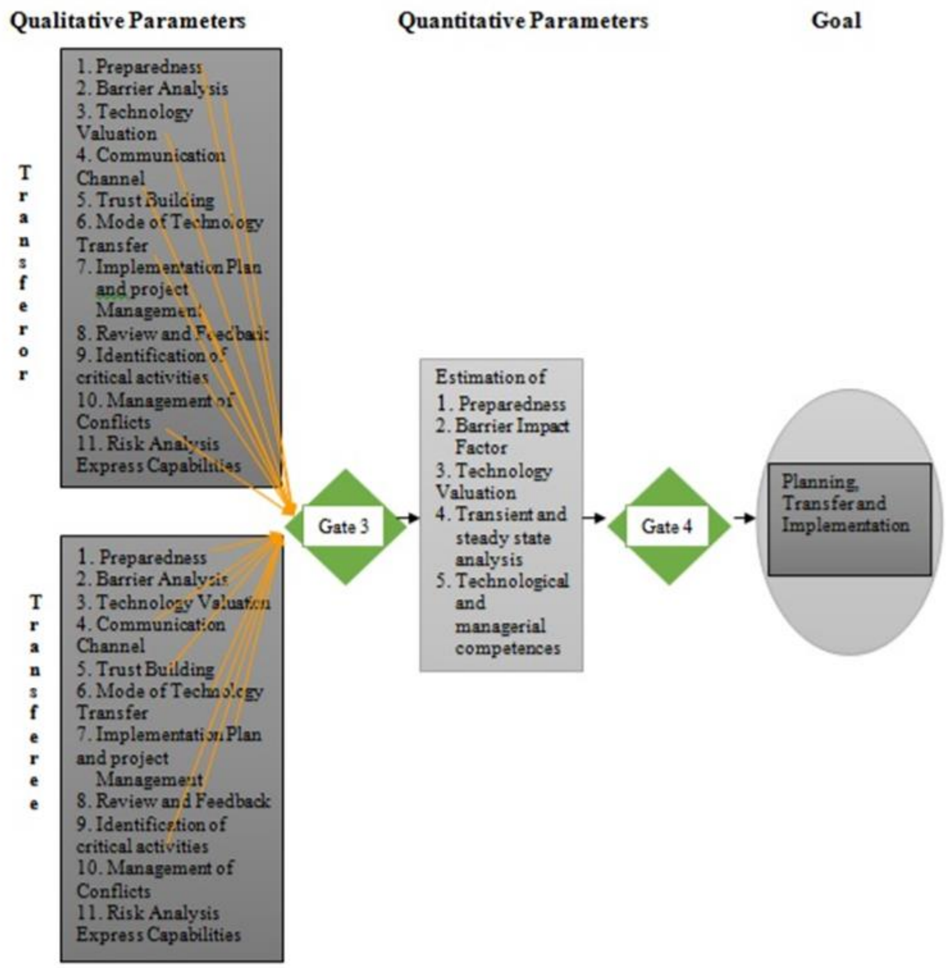
Technology Transfer in the Construction Industry (Uusitalo and Lavikka, 2020)



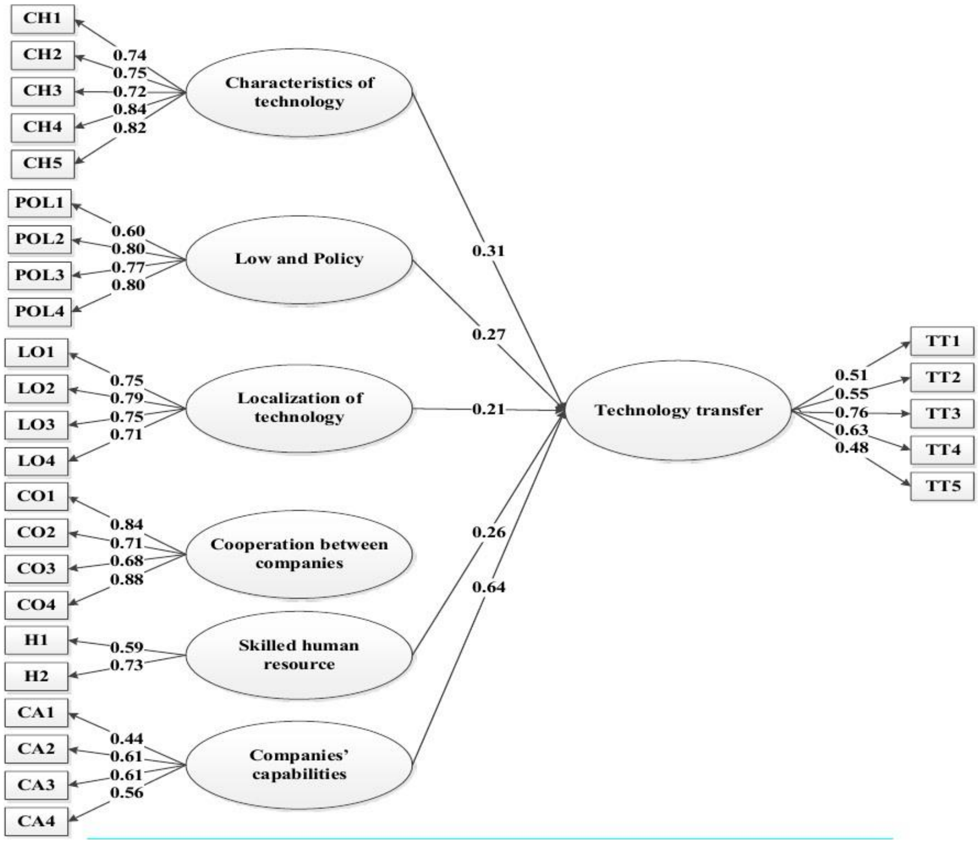
Modelling a Conceptual Framework of Technology Transfer Process in Construction Projects: An Empirical Approach (Owusu-Manu *et al.,* 2017)



Conceptual TT Model for managing technology transfer for public R&D institutions in India (Purushotham *et al., 20*15)



Technology Transfer Model Process: Planning and Implementation Stage (Kundu *et al., 20*15)



An Empirical Study on Factors Influencing Technology Transfer Using Structural Equation Modelling (Alizadeh *et al.*, 2018)

Appendix D External Expert Verification of Question Interviews

INDUCTION INTERVIEW QUESTIONS

Induction Interview Questions	Expert Reviewer's Comment
1. Conceptions of technology	
A. What are the agency's requirements for Technology Transfer?	
B. How does the agency identify the requirements for Technology Transfer?	
C. What are the current Technology Transfer used?	
2. Technological Activity and transfer	
A.How do you or the agency do the planning for Technology Transfer Program/Projects?	
B. Do you put any proper mechanism to monitor the activities?	
3. Communication channels	
A.What are the current communication channels for Technology Transfer process and activities?	
B.Does the communication channels effective?	
C. If not, what are the improvement to the communication channels?	
4. Modes of Technology Transfer?	
A. What are the Modes of Technology Transfer? (Classroom, OJT, Site Visit, Supervision)	
B. What are the most used modes of Technology Transfer?	
C. Which modes in your opinion is the most effective?	
5. Factors affecting Technology Transfer	
Does this factor affects? Yes or No **Transfer Environment** - Complexity of Technology - Construction Mode (e.g. JV vs Sub-contracting)	

- Government Policy - Government Enforcement **Learning Environment** - Relationship between WPCs and Recipients - Mutual Trust - Clear Understanding of the scope of technology transfer - Effective communication - Strong commitment from senior management of WPCs and Recipients - Teamwork - Supervision **WPCs Characteristics** - Willingness to implement - Degree of Experience - Appropriate Management practices and approaches **Recipient's Characteristics** - Willingness to learn - Experience working with Foreigners - Appropriate Management practices and approaches - Adequate knowledge base	
6. Impact/Results of Technology Transfer	
A.What do you consider as the Impact/results of Technology Transfer in the project? (Competitiveness, financial, quality)	
B. What are the measurement used by the agency to measure Technology Transfer results?	
7. Gaps in the Technology Transfer Process	
A. What are the Lessons Learned from the previous technology transfer process?	
B. What are further improvement that you can suggest to technology transfer process?	

Name of Expert Reviewer:

[Name]

[Position]

[Organisation]

Signature :

Date :

Appendix E Survey Form (Primary Study)

QUESTIONNAIRE SURVEY

DEVELOPMENT OF A TECHNOLOGY TRANSFER MODEL FOR THE KLANG VALLEY MASS RAPID TRANSIT (KVMRT) PROJECT

This survey aims to gather data for measuring the effectiveness of Technology Transfer in the KVMRT Project. You are requested to kindly fill in the questionnaire. The information will be used for academic purposes only. Individual responses will be kept confidential. Only a consolidated summary of the result may be published. You may contact the researcher for any enquiries. Your cooperation is highly appreciated.

Definition of Technology Transfer

For the purpose of this Study, Technology Transfer (TT) can be defined as when all types of knowledge relating to the field (e.g. design, process, material use, equipment utilization, etc.) are transferred from a foreign party (transferor) to a host party (transferee) that arranges to receive it.

RESPONDENT'S BACKGROUND

Type of Organization:

☐ Main Contractor ☐ Sub-contractor ☐ Consul-tant ☐ University ☐ Govern-ment ☐ Others :_____

Sex: ☐ Male ☐ Female

Age:

☐ Below, 20 ☐ 20 – 30 ☐ 30 – 40 ☐ 40 – 50 ☐ 50+

Education:

☐ SPM ☐ Diploma ☐ Bachelor Degree

☐ Master Degree ☐ Doctorate Degree ☐ Other:________________

How many years of **working experience** do you have?

General ☐ 0 – 5 ☐ 6 - 10 ☐ 11 - 15 ☐ 16 -, 20 ☐ 20+

Rail Industry ☐ 0 - 5 ☐ 6 - 10 ☐ 11 - 15 ☐ 16 -, 20 ☐ 20+

How many **projects** have you been involved that have Technology Transfer Programme?

☐ 0 ☐ 1 - 5 ☐ 6 - 9 ☐ 10+

How many **trainings or knowledge transfer** session have you participated that relates to a Technology Transfer Programme?

☐ 0 ☐ 1 - 5 ☐ 6 - 9 ☐ 10+

In your opinion, in which **stage of construction** does knowledge / technology transfer occurs the most?

☐ Preliminary Design ☐ Detailed Design ☐ Construction / Manufacturing ☐ Installation, Testing & Commissioning

In the following sections, please rate the degree of importance and relevance of this factor in your experience in the implementation of a Technology Transfer (TT) Program

PART A. ENABLERS: Please CIRCLE your selected rating number in COLUMN A

1	2	3	4	5
Very Low	**Low**	**Moderate**	**High**	**Very High**

Item Code	F1 – TECHNOLOGY TRANSFER PLANNING : concerned with the planning of the main project with relation to Technology Transfer process	COLUMN A - Rate the degree of importance and relevance of the factor				
		Very Low	**Low**	**Mode-rate**	**High**	**Very High**
T1	**Initial Planning (industry gaps requirement, etc.)** is critical to ensure a successful Technology Transfer program	1	2	3	4	5
T2	**Preliminary assessment and selection** of the potential technology providers and recipients is critical to ensure a successful Technology Transfer program	1	2	3	4	5
T3	A detail **technology transfer requirement included in the tender** for a work package contract is critical for a successful technology transfer program	1	2	3	4	5

Item Code	F2 – TRANSFER ENVIRONMENT: concerned with the overall environment of the main project with relation to Technology Transfer process	COLUMN A - Rate the degree of importance and relevance of the factor				
		Very Low	**Low**	**Mode-rate**	**High**	**Very High**
T4	The **technology transfer channel** (i.e. joint venture, licensing, sub-contracting, etc.) will affect the effectiveness of a technology transfer program	1	2	3	4	5
T5	**Government policy** is essential for encouraging Technology Transfer program	1	2	3	4	5
T6	**Government enforcement** of related policies is essential for encouraging Technology Transfer program	1	2	3	4	5
T7	**Effective coordination & monitoring** is critical for the success of a Technology Transfer program	1	2	3	4	5
Item Code	**F3 – LEARNING ENVIRONMENT:** concerned with the relationship and communication between	**COLUMN A - Rate the degree of importance and relevance of the factor**				

	the technology provider and recipient in the TT process	**Very Low**	**Low**	**Mode-rate**	**High**	**Very High**
T8	The **different culture or nationality** between the technology provider and recipient could impact the technology transfer process	1	2	3	4	5
T9	**Mutual trust** will help to create a good relationship between the provider and recipient	1	2	3	4	5
T10	**Clear understanding of technology transfer scope** for both the provider and recipient is essential for effective technology transfer	1	2	3	4	5
T11	**Effective communication** is essential for successful Technology Transfer	1	2	3	4	5
T12	A **strong commitment by the senior management** to Technology Transfer programmes is essential for their success.	1	2	3	4	5
T13	**Good teamwork** between the provider and recipient project team encourages Technology Transfer.	1	2	3	4	5
T14	The technology provider should provide an **adequate facility** to ensure that Technology Transfer occurs.	1	2	3	4	5
T15	A **high degree of interest by both provider and recipient** is essential for a good learning environment	1	2	3	4	5
T16	The technology provider should ensure **sufficient and close supervision** so that the Technology Transfer process actually occurs	1	2	3	4	5

Item Code	**F4 – TECHNOLOGY PROVIDER CHARACTERISTICS:** concerned with the characteristics of the technology provider and how they impact on the TT process.	**COLUMN A - Rate the degree of importance and relevance of the factor**				
		Very Low	**Low**	**Mode-rate**	**High**	**Very High**
T17	The **technology provider's willingness to implement** Technology Transfer initiatives and being cooperative is critical to the success of the TT programmes	1	2	3	4	5
T18	The **technology provider's degree of experience** working on international projects has an impact on the successfulness of TT programmes	1	2	3	4	5
T19	Technology provider's **management practices and procedures** (i.e. leadership style, project management etc.) are essential for effective TT	1	2	3	4	5
T20	**Technology provider** with an **extensive knowledge base** in advanced project management and technology are essential for effective TT to occur.	1	2	3	4	5

T21	**Technology provider** need to be **honest and transparent** in their approach of the Technology Transfer process	1	2	3	4	5

Item Code	F5 – **RECIPIENT'S CHARACTERISTICS**: concerned with the characteristics of the Recipient of technology and how they impact on the Technology Transfer (TT) process.	COLUMN A - Rate the degree of importance and relevance of the factor				
		Very Low	Low	Mode-rate	High	Very High
T22	The recipient's **willingness to learn** new technologies from the technology provider and **change their existing work practices** has a bearing on the success of TT programmes	1	2	3	4	5
T23	The recipient's **degree of experience working with foreigner/technology provider** has an impact on the successfulness of TT programmes	1	2	3	4	5
T24	The recipient has **appropriate management practices and approaches** (i.e. leadership style, project management etc.) are essential for effective TT	1	2	3	4	5
T25	Recipient's with an **adequate knowledge base** to learn more advanced skills (i.e. sufficient formal training, qualifications and experience, etc.) are essential for effective TT to occur.	1	2	3	4	5

PART B. OUTCOMES: Please CIRCLE your selected rating number in COLUMN A

COLUMN A: From your experience, rate the actual outcome of these factors in your previous Technology Transfer (TT) project or exercise using the following scale below.

1	2	3	4	5
Very Low	Low	Moderate	High	Very High

Item Code	O1 – **ECONOMIC ADVANCEMENT**: concerned with the improvement in economic conditions of your industry due to TT programmes.	COLUMN A - Rate the degree of the actual outcome				
		Very Low	Low	Mode-rate	High	Very High
T26	TT programmes enhanced our company's **competitiveness** in the market.	1	2	3	4	5
T27	TT programmes enhanced our company's **overall performance** over the long-term (i.e. better management skills, improved quality, etc.)	1	2	3	4	5
T28	TT programmes enhanced our company's **overall profitability** over the long-term	1	2	3	4	5
T29	Technology transfer programmes allows our company **to be more innovative** and produce new products or services	1	2	3	4	5

Item Code	O2 – **KNOWLEDGE ADVANCEMENT**: concerned with the impact of TT programmes on the recipient's knowledge base (i.e. skills, practices, etc.)	**COLUMN A - Rate the degree of the actual outcome**				
		Very Low	**Low**	**Mode-rate**	**High**	**Very High**
T30	TT programmes help improved the **knowledge and skill** of local workers.	1	2	3	4	5
T31	Recipients who have gained new knowledge from TT programmes utilize this knowledge to **enhance their working practices.**	1	2	3	4	5
T32	Technology transfer **enhances local workers competency** and accelerate their career progression and increase their salary over the long term.	1	2	3	4	5

Item Code	O3 – **PROJECT PERFORMANCE**: concerned with the impact of TT programmes on the performance of design and projects.	**COLUMN A - Rate the degree of the actual outcome**				
		Very Low	**Low**	**Mode-rate**	**High**	**Very High**
T33	TT programmes **enhanced the project financial performance** (i.e. project budget, profitability, cash flow, etc.) of our projects.	1	2	3	4	5
T34	TT programmes **enhanced the project schedule performance** (i.e. on-time project completion, resource management, etc.) of our projects.	1	2	3	4	5
T35	TT programmes **enhanced the quality standards** on our projects (i.e. less re-work, satisfied clients and improved products).	1	2	3	4	5

Background Information (*Optional)

Could you please provide some information about yourself?

Name: ____

Position: ____

Name of Organization: ____

Contact Address: ____

Phone: __________________________ E-Mail:____________________

Appendix F Theme Frequencies from NVivo 12 Analysis (Primary Study 1)

Theme Frequencies Identified from NVivo 12 Analysis

Theme	Frequency	Meaning	Evidence
Technology Transfer Planning	10	Any activities concerning the initial preparation of the implementation for the technology transfer process and programme (Rose, 1995; Smith, 1995).	"For MRT requirement, technology transfer is related to the technical team, so we requested respective Systems team what their requirements [*sic.*]." (A2) "The objective of the technology transfer is defined together with Malaysian Industry Government Group for High Technology (MIGHT) at that time. MIGHT already have the gap analysis and rail blueprint." (A3)
Technology Transfer Channel	13	The channel for the technology to flow from its provider to the recipient (A. Khan, 2011; Waroonkun, 2007).	"Joint Venture is much more effective as they will do it together and that is more effective." (A3)

Theme	Frequency	Meaning	Evidence
			“There is technology transfer in the process of assembly, installation, testing and commissioning.” (A6)
Learning Environment	16	The soft skill or hard infrastructure put in place for technology transfer (Awang *et al.*, 2008; Jusoff *et al.*, 2009).	“On-Job-Training (OJT) is the best, but you cannot accommodate all. There is a limitation to participants.” (A1) “During OJT they get to get to be involved in the process even though at that time they do not know the right [*sic*.].” (A3)
Government Policy	4	The specific government policy in encouraging and also enforcing technology transfer in the project (Balakrishnan, 2007; Dinakar, 2011).	“MRT follows the Offset Requirement Document (ORD) set by the government for the technology transfer.” (A1) “The Offset Requirement document given by the government is only for the tender stage.” (A2)

Theme	Frequency	Meaning	Evidence
Technology Transfer Environment	8	The overall ecosystem governing the KVMRT technology transfer programme from planning to implementation (A. Khan, 2011; Awang *et al.*, 2008).	"The government policy is there only to make sure the Works Package Contractors fulfil their Offset obligations." (A4) "The government already have the gap analysis and blueprint." (A4)
Coordination & Monitoring	8	The coordination and monitoring of the overall technology transfer programme from planning to implementation (Hamdan, 2015; Rose, 1995; Waroonkun, 2007).	"Because of offset, we have meeting and progress update [*sic*.]. There is a structured approach." (A2) "Monitoring is done through project management such as project meetings." (A6)
Communication Channel	6	The communication flow between related parties and stakeholders with regards to the technology transfer programme (Khayat, 2015; Waroonkun, 2007).	"The communication mechanism is effective. Will improve better with no intervention from external parties." (A1) "The communication channel is good because we have the MRT ICP Committee

Theme	Frequency	Meaning	Evidence
			and the working committee." (A3)
Technology Provider's Characteristics	6	The technology provider's organisational behaviour and structure that relates to implementing the technology transfer programme (Khayat, 2015; Rose, 1995).	"Due to the technology [being] the WPC's core business, there is limited technology transfer." (A5) "We need to consider WPC's limitation such as space, trainer availability and facilities." (A3)
Technology Recipient's Characteristics	13	The technology recipient's organisational behaviour and structure that relates to implementing the technology transfer programme (A. Khan, 2011; Waroonkun, 2007).	"The recipient must be ready. They should not use this opportunity as a way to get jobs." (A4) "The recipient should be from people who have experience [of] an effective technology transfer." (A5)

Appendix G Pearson Correlation Matrix

Pearson Correlation Matrix (T1 to T17)

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16	T17
T1	1																
T2	0.743 **	1															
T3	0.512 **	0.610 **	1														
T4	0.347 **	0.405 **	0.443 **	1													
T5	0.372 **	0.387 **	0.431 **	0.443 **	1												
T6	0.352 **	0.361 **	0.400 **	0.308 **	0.782 **	1											
T7	0.441 **	0.443 **	0.469 **	0.402 **	0.588 **	0.618 **	1										
T8	0.053	0.091	0.045	0.172 *	0.014	-0.056	0.062	1									
T9	0.317 **	0.362 **	0.356 **	0.254 **	0.284 **	0.224 **	0.389 **	0.235 **	1								
T10	0.426 **	0.421 **	0.430 **	0.312 **	0.461 **	0.446 **	0.551 **	0.073	0.478 **	1							
T11	0.398 **	0.341 **	0.380 **	0.259 **	0.406 **	0.382 **	0.497 **	0.118	0.447 **	0.691 **	1						

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16	T17
T12	0.370 **	0.384 **	0.390 **	0.379 **	0.437 **	0.425 **	0.548 **	0.113	0.419 **	0.584 **	0.629 **	1					
T13	0.371 **	0.385 **	0.392 **	0.307 **	0.371 **	0.323 **	0.504 **	0.155 *	0.508 **	0.587 **	0.634 **	0.627 **	1				
T14	0.285 **	0.352 **	0.391 **	0.265 **	0.337 **	0.256 **	0.454 **	0.157 *	0.354 **	0.474 **	0.498 **	0.542 **	0.487 **	1			
T15	0.337 **	0.359 **	0.421 **	0.296 **	0.411 **	0.403 **	0.481 **	0.060	0.389 **	0.571 **	0.543 **	0.574 **	0.554 **	0.519 **	1		
T16	0.289 **	0.330 **	0.336 **	0.359 **	0.320 **	0.274 **	0.434 **	0.150 *	0.409 **	0.488 **	0.523 **	0.500 **	0.555 **	0.547 **	0.598 **	1	
T17	0.323 **	0.355 **	0.407 **	0.283 **	0.409 **	0.375 **	0.452 **	0.068	0.368 **	0.551 **	0.542 **	0.482 **	0.501 **	0.472 **	0.536 **	0.532 **	1
T18	0.410 **	0.364 **	0.393 **	0.266 **	0.437 **	0.370 **	0.499 **	0.152 *	0.470 **	0.530 **	0.539 **	0.455 **	0.417 **	0.507 **	0.536 **	0.543 **	0.659 **
T19	0.350 **	0.398 **	0.404 **	0.317 **	0.286 **	0.252 **	0.384 **	0.264 **	0.455 **	0.394 **	0.423 **	0.374 **	0.496 **	0.378 **	0.446 **	0.491 **	0.523 **
T20	0.438 **	0.402 **	0.429 **	0.336 **	0.366 **	0.325 **	0.397 **	0.106	0.447 **	0.484 **	0.484 **	0.390 **	0.465 **	0.403 **	0.448 **	0.440 **	0.590 **
T21	0.379 **	0.393 **	0.355 **	0.297 **	0.353 **	0.303 **	0.448 **	0.105	0.429 **	0.523 **	0.518 **	0.414 **	0.519 **	0.459 **	0.454 **	0.569 **	0.570 **
T22	0.388 **	0.359 **	0.465 **	0.272 **	0.450 **	0.360 **	0.457 **	0.030	0.433 **	0.564 **	0.553 **	0.465 **	0.490 **	0.352 **	0.507 **	0.429 **	0.538 **
T23	0.197 **	0.286 **	0.335 **	0.261 **	0.144 *	0.192 **	0.225 **	0.266 **	0.326 **	0.188 **	0.232 **	0.257 **	0.312 **	0.198 **	0.269 **	0.266 **	0.295 **

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16	T17
T24	0.262 **	0.332 **	0.337 **	0.181 **	0.251 **	0.274 **	0.339 **	0.048	0.373 **	0.397 **	0.393 **	0.368 **	0.457 **	0.303 **	0.444 **	0.402 **	0.286 **
T25	0.209 **	0.338 **	0.304 **	0.303 **	0.253 **	0.247 **	0.368 **	0.145 *	0.407 **	0.381 **	0.353 **	0.393 **	0.444 **	0.375 **	0.345 **	0.438 **	0.403 **
T26	0.334 **	0.346 **	0.389 **	0.306 **	0.358 **	0.337 **	0.405 **	0.072	0.394 **	0.433 **	0.386 **	0.349 **	0.447 **	0.257 **	0.369 **	0.324 **	0.369 **
T27	0.303 **	0.355 **	0.412 **	0.287 **	0.335 **	0.272 **	0.324 **	-0.013	0.420 **	0.457 **	0.393 **	0.387 **	0.432 **	0.277 **	0.359 **	0.316 **	0.373 **
T28	0.305 **	0.300 **	0.396 **	0.161 **	0.278 **	0.174 *	0.160 *	0.025	0.302 **	0.270 **	0.287 **	0.203 **	0.331 **	0.241 **	0.305 **	0.268 **	0.379 **
T29	0.356 **	0.434 **	0.468 **	0.312 **	0.428 **	0.394 **	0.373 **	0.060	0.390 **	0.468 **	0.414 **	0.333 **	0.438 **	0.298 **	0.441 **	0.386 **	0.437 **
T30	0.353 **	0.371 **	0.463 **	0.290 **	0.385 **	0.346 **	0.424 **	-0.053	0.294 **	0.379 **	0.301 **	0.361 **	0.385 **	0.369 **	0.445 **	0.336 **	0.384 **
T31	0.399 **	0.435 **	0.426 **	0.289 **	0.412 **	0.340 **	0.382 **	0.051	0.354 **	0.392 **	0.422 **	0.297 **	0.473 **	0.335 **	0.461 **	0.409 **	0.435 **
T32	0.405 **	0.319 **	0.333 **	0.230 **	0.333 **	0.289 **	0.401 **	0.041	0.306 **	0.390 **	0.406 **	0.343 **	0.416 **	0.311 88	0.419 **	0.395 **	0.402 **
T33	0.287 **	0.324 **	0.324 **	0.220 **	0.223 **	0.169 *	0.230 **	0.138	0.346 **	0.348 **	0.254 **	0.248 **	0.421 **	0.157 *	0.336 **	0.246 **	0.283 **
T34	0.257 **	0.294 **	0.296 **	0.174 *	0.229 **	0.224 **	0.305 **	0.100	0.395 **	0.382 **	0.321 **	0.254 **	0.353 **	0.157 *	0.277 **	0.260 **	0.292 **
T35	0.444 **	0.395 **	0.384 **	0.224 **	0.277 **	0.255 **	0.349 **	0.120	0.298 **	0.465 **	0.435 **	0.365 **	0.397 **	0.198 **	0.391 **	0.330 **	0.361 **

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

Pearson Correlation Matrix (T18 to T35)

	T18	T19	T20	T21	T22	T23	T24	T25	T26	T27	T28	T29	T30	T31	T32	T33	T34	T35
T19	0.569 **	1																
T20	0.613 **	0.607 **	1															
T21	0.572 **	0.577 **	0.640 **	1														
T22	0.481 **	0.374 **	0.491 **	0.486 **	1													
T23	0.302 **	0.361 **	0.275 **	0.276 **	0.298 **	1												
T24	0.370 **	0.345 **	0.310 **	0.270 **	0.431 **	0.474 **	1											
T25	0.361 **	0.380 **	0.323 **	0.375 **	0.402 **	0.518 **	0.478 **	1										
T26	0.300 **	0.411 **	0.384 **	0.446 **	0.456 **	0.291 **	0.389 **	0.386 **	1									
T27	0.328 **	0.413 **	0.390 **	0.378 **	0.458 **	0.255 **	0.340 **	0.342 **	0.711 **	1								
T28	0.282 **	0.381 **	0.339 **	0.299 **	0.399 **	0.260 **	0.310 **	0.179 *	0.584 **	0.614 **	1							

	T18	T19	T20	T21	T22	T23	T24	T25	T26	T27	T28	T29	T30	T31	T32	T33	T34	T35
T29	0.373 **	0.405 **	0.387 **	0.412 **	0.484 **	0.374 **	0.422 **	0.308 **	0.585 **	0.640 **	0.558 **	1						
T30	0.387 **	0.347 **	0.371 **	0.364 **	0.499 **	0.305 **	0.340 **	0.305 **	0.453 **	0.524 **	0.469 **	0.531 **	1					
T31	0.477 **	0.452 **	0.426 **	0.429 **	0.528 **	0.375 **	0.374 **	0.389 **	0.446 **	0.493 **	0.487 **	0.582 **	0.576 **	1				
T32	0.474 **	0.373 **	0.429 **	0.509 **	0.465 **	0.310 **	0.325 **	0.356 **	0.490 **	0.463 **	0.397 **	0.508 **	0.637 **	0.620 **	1			
T33	0.269 **	0.331 **	0.272 **	0.266 **	0.281 **	0.402 **	0.401 **	0.304 **	0.478 **	0.386 **	0.407 **	0.422 **	0.372 **	0.400 **	0.371 **	1		
T34	0.325 **	0.407 **	0.319 **	0.274 **	0.266 **	0.392 **	0.369 **	0.283 **	0.417 **	0.414 **	0.320 **	0.466 **	0.359 **	0.360	0.388 **	0.688 **	1	
T35	0.386 **	0.309 **	0.356 **	0.396 **	0.411 **	0.317 **	0.321 **	0.251 **	0.454 **	0.443 **	0.412 **	0.520 **	0.522 **	0.427 **	0.540 **	0.512 **	0.558 **	1

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

LIST OF PUBLICATIONS

Journal with Impact Factor

1. **Hamdan, A. R.,** Fathi, M. S. & Mohamed, Z. (2018). Evolution of Malaysia's Technology Transfer Model Facilitated by National Policies, International Journal of Engineering & Technology, *7*(2.29), 196-202. (Indexed by SCOPUS)

2. **Hamdan, A. R.,** Fathi, M. S. & Mohamed, Z. (2018a). The Critical Success Factors for the Technology Transfer in Klang Valley Mass Rapid Transit Project, The Journal of Social Sciences Research(2), 166-172. (Indexed by SCOPUS)

3. **Hamdan, A. R.,** Fathi, M. S. and Mohamed, Z. (2020). Leveraging Public Infrastructure Project as a Driver for Technology Development - A Case Study on a Technology Transfer Model for the Klang Valley Mass Rapid Transit Development Project, International Journal of Research and Innovation in Social Science, IV(VIII), 408 -420. (IF (2014):5.611)

Non-Indexed Conference Proceedings

1. **Hamdan, A. R.,** Fathi, M. S. & Mohamed, Z. (2017). Technology Transfer in the Klang Valley Mass Rapid Transit Project: Key Success Factors, Paper presented at 1st International Conference on Sustainable Infrastructure and Engineering 2017. Kuala Lumpur.