

**TECHNOLOGY TRANSFER FROM FOREIGN
CONTRACTORS TO LOCAL CONTRACTORS**

**A CASE STUDY FROM NEW KELANI BRIDGE
CONSTRUCTION PROJECT**

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TECHNOLOGY TRANSFER FROM FOREIGN CONTRACTORS TO LOCAL CONTRACTORS

A CASE STUDY FROM NEW KELANI BRIDGE CONSTRUCTION PROJECT

**A study has been carried out to assesses Technology Transfer in New
Kelani Bridge Construction Project Implemented by the Road
Development Authority Sri Lanka**

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Thesis/ Dissertation submitted in partial fulfilment of the requirements for the degree
Master of Science

Department of Civil Engineering

University of Moratuwa
Sri Lanka

October 2022

DECLARATION

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out this research for the Masters dissertation under my supervision.

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ABSTRACT

The highway infrastructure development sector contribute massively to the economic growth in Sri Lanka and Technology Transfer (TT) is essential to advancement of technologies used in construction. The road sector of Sri Lanka has taken series of initiatives on TT with their foreign funded road construction projects. Despite the involvement of local professionals in above projects, the outcome of technology transfer into Sri Lanka has not been evaluated to improve the rates of TT. Therefore, this research was carried out with the objective of appraising the effectiveness of Technology Transfer (TT) through local professionals based on the case study of New Kelani Bridge Construction Project (NKBP). A previously developed framework from literature review was utilized which has main seven enablers and value creations such as transfer environment, transferor characteristics of transferor, characteristics of transferee, advancement of the economy, advancement of knowledge and performance of the project. A questionnaire-based survey was used to collect the data from forty-seven (47) local professionals directly involved in project activities. The collected data was analyzed according to the framework and recommendations were summarized. TT Index of 76 was determined for overall performance of the NKBP and contract package 2 was the most effective in transferring technology among other contract packages with a TT index of 85. Dealing with government influences under the main factor of transfer environment had the lowest success values. Having studied the case in depth, reviewing the government policies, evaluation of government enforcement, encouraging joint venture arrangements with foreign companies, providing more training opportunities, conducting performance evaluations of local professionals after training are recommended to improve the underperforming perspectives of technology transfer in the future projects. This report assists Sri Lankan Road construction companies and government agencies to re-evaluate their policies.

Key words: Technology Transfer (TT), Sri Lanka, Highway infrastructure, Technology Transfer Index

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LIST OF ABBREVIATIONS

Abbreviation	Description
TT	Technology Transfer
NKBP	New Kelani Bridge Project
JICA	Japan International Cooperation Agency
SMCC	Sumitomo Mitsui Cooperation Company
RDA	Road Development Authority
GOSL	Government of Sri Lanka
JMT	JFE Engineering, Mitushi Engineering and Ship Building and Toda Cooperation
FDI	Foreign Direct Investment
MOH	Ministry of Highways

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CHAPTER 1: INTRODUCTION

1.1 Introduction

Large numbers of highway infrastructure development work have been carried out island wide for last two decades in Sri Lanka. Most of the major projects were carried out by foreign funding by the foreign consultants and contractors with advanced technologies and technical knowledge with good practices. Though local professionals involved with above projects, the outcome of technology transfer to Sri Lanka has not been evaluated and the government policies have not been re-reviewed. This study, therefore, was aimed at assessing Technology Transfer (TT) based on this case study of New Kelani Bridge Construction Project.

Japan International Cooperation Agency (JICA) has lent the Sri Lankan government 35,020 million yen for this project and the Road Development Authority which is under the Ministry of Highways of Sri Lanka has implemented it. The key objective of New Kelani Bridge Project was to scatter and diminish the congestion of traffic by building a new bridge across the Kelani River which serves as a link of increased mobility. This is aimed towards improving the network of transport in Colombo city and promoting the development of economy of the country. Technology Transfer through Japanese construction companies was included in the one of main objectives of this project.

New Kelani Bridge Construction Project has mainly two construction packages, steel box girder section-package 1 and extradosed bridge section-package 2. Main contractors for package 1 are joint venture of JFE Engineering (Japan), Mitushi Engineering and Ship Building (Japan) and Toda Cooperation (Japan) (JMT). Main Contractors for package 2 are Sumitomo Mitushi Cooperation Company (SMCC) (Japan), and Sanken private limited (Sri Lanka). Joint Venture of Oriental Consultants Private Limited and Katahira International Private Limited (Japan) in association with Consulting Engineers Architects Private limited and Project

Management International Private Limited (Sri Lanka) served as the consultant for both packages.

JMT is making use of most-up-to-date technology in steel fabrication and erection of steel box girder bridges and SMCC-SANKEN is using new technology such as balanced cantilever method, Power blender method e.tc. The absorption of above technologies into Sri Lankan construction industry is an asset to the county. For this study, the effectiveness of TT was measured with relevance to enablers and the value-creators through the process of TT, as specified frame work in the literature.

The foreign direct investment (FDI) is essential for Sri Lanka to enhancing and managing its own resources with advance technologies from foreign countries. According to a study done by Ofori (Ofori,2000) foreign companies have both constructive and destructive influence on the host country's construction industry irrespective of the mode of entry. In another study it was found that in most of the major highway development projects initiated with foreign direct investments, foreign investor have control over management of assets and profits (Graham J, 2005). Promotion of FDI inflow into a developing country was found to be a major solution to dissolve economic and social issues encountered by host countries (Ram et al., 2002). Therefore positive impact on FDI is powerful than negatives.

1.2 Problem statement

Sri Lanka has developed a wide range of highway infrastructure over the last two decade, with help from foreign funds, consultants, and contractors with advanced technology and knowledge. The technology transfer through above projects have contributed significantly to the economic growth of the country. Despite the involvement of local professionals in above projects, the outcome of technology transfer into Sri Lanka has not been evaluated. Such projects are not subjected to a re-evaluation by the government. The degree of technology transfer should be evaluated in order to take mitigation measures to get the maximum benefit to the country. In addition to identifying better investment opportunities, this type of evaluation will help eliminate the negative impacts caused by foreign investments.

As a result, underperforming technology transfer process could be developed using best practices for continuous improvement. A case study of the New Kelani Bridge Construction project was used to assess the Technology Transfer (TT).

This study, therefore, was aimed at assessing Technology Transfer (TT) through local professionals based on case study of New Kelani Bridge Construction Project implemented by Road Development Authority (RDA).

1.3 Research Objectives

The research objectives are illustrated here under general objective and specific objectives.

1.3.1 General Objective

The objective of this research is to appraise the effectiveness of Technology Transfer (TT) through local professionals in order to improve rates of TT in the Sri Lankan foreign funded road construction projects.

1.3.2 Specific objectives

The following are the specific objectives of the study.

- To evaluate technology transfer of New Kelani Bridge Project using a proposed model in literature.
- To propose strategies to increase the amount and quality of TT in the foreign aided road development projects.

1.4 Significance of Research

Design and Construction of Extradosed Bridge for Package 2 of New Kelani Bridge Project is the first of its kind in Sri Lanka. It will be the largest and longest span bridge in Sri Lanka and it has been recorded where largest concrete volume has been used for a highway infrastructure projects in Sri Lanka. Design, fabrication and erection of steel piers, steel box girders and steel/concrete deck for Package 1 of New Kelani Bridge Project will be recorded where largest steel volume has been used in Sri Lanka. Both of these contract packages of new kelani bridge project carry modern technology and it is a rare opportunity to absorb that technology to Sri Lanka to sustain it for future construction industry of Sri Lanka.

The present progress of project is more than ninety percent and stay cable installation and balanced cantilever construction of package 2 contract Extradosed bridge is to be completed in few months. Steel pier, girder and fabrication were fully completed and most of erections of that were completed and continued. It is recognised as best time to evaluate the level of transfer of technology through this project. Therefore, a research is necessary to evaluate the level of technology transfer through this project.

1.5 Methodology

This research made use of quantitative research strategies to review and evaluate the degree of technology transferred through the New Kelani Bridge Construction Project. The questionnaire comprised of 29 questions was used to collect the data in order to evaluate the degree of technology transfer though the New Kelani Bridge Project. The questionnaire represented all the variables in the concept model proposed by (Stewart,waroonokun, 2007) has been used for respondents to collect quantitative data. As qualitative data, the specifics of the TT process's issues and suggestions for improvement were obtained.

Total of 200 local professionals from Road Development Authority, Consultants (OC KEI JV) and both Contractors JMT JV and SMCC-SANKEN JV were directly engaged in the project. The Concept model of Stewart and Waroonkun (2007) was used to analyse the data and determine the overall technology transfer index and for

New Kelani Bridge Project. Further Comparative analysis was carried out among main project participants.

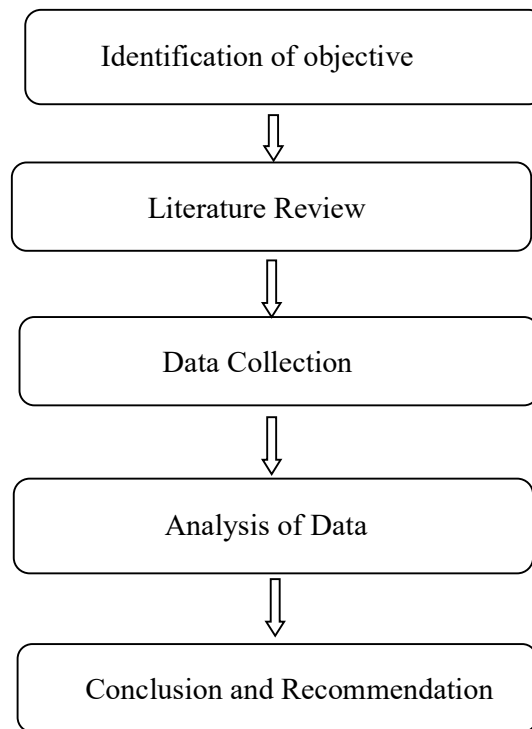


Chart 1.1: Flow chart of Methodology of study

CHAPTER 2 – Literature Review

2.1 Introduction

Sri Lanka is one of the main asian country which boost their economy by the implementing development projects with TT transfer. (Marton, 1986)

2.2 Definition of technology transfer

TT was described differently by researchers according to their diverse fields. Tatum (1998) gives a definition which is more relevant to the construction industry. Tatum explains TT as transfer of resources, instruments, construction operations and procedures inside the project scope. In this research, a similar definition for TT was taken from Stewart and Waroonkun (2007). According to them TT is the transfer of a combination of all types of knowledge bases such as, use of materials, construction process, utilization of various equipment and construction design, to a transferee (host) from a transferor (foreign input) which makes the necessary arrangements to receive them.

2.3 Evaluation of Technology Transfer

In history, few studies were carried out to create a frame work for effectiveness of TT in development projects. The literature was reviewed to select a suitable a concept model to evaluate the TT in Sri Lankan Road construction industry. Following technology transfer models were explored from the literature.

Knowledge Transfer Model

The Knowledge Transfer Model developed by (Wang P., Tong T.W ,Koh, C.P, 2004) aimed to understand how knowledge is transferred from a multinational company to a subsidiaries in China. 62 no of companies were interviewed and found two main steps of TT procedure. The initial step is to make attention to extent of transferor's knowledge and willingness to pass it over to transferee. The extent of transferee's knowledge and willingness to acquire knowledge from transferor are scrutinized as a

second step. The model's intrinsic flaw is that model is restricted to multinational companies and not applicable in general use.

Technology Acquisition Model

Technology Acquisition Model developed by (Simkoko, 1992) focus on TT in the construction industry of developing countries. This model was developed based on case studies of 12 construction projects undertaken in developing countries in Africa, South America and Asia. The objective was to determine whether TT programs and other factors within and outside the construction project environment affected construction project performance. Project delivery system, project management teams, transfer programs, client characteristics, project characteristics, design and construction technologies, and project performance are the seven elements. This research represents only available construction sector specific technology. However, the study limited itself to examining local technological and management practices and did not model the technology transfer enabling process. However this model provides insight into factors contributing to TT in construction projects.

Extended Technology Transfer Project Life Cycle Model

(Saad M, 2002) created this model to evaluate the TT in Algeria based on TT mechanisms such as Turnkey and product in hand. The proposed model explicitly took into account the contracts that regulate TT projects. Purchasing and acquiring of hardware, software, and knowledge are assumed to be pertinent to certain commercial and state circumstances. There are various difficult problems connected to how different parties affect the TT process. However, this study came to the conclusion that there are four subcategories of project success: the degree to which the project adheres to the timeline and budget; the influence it has on customers; the success of the project's direct or indirect business; and the project's potential for future growth.

Comparative Marketing Model

Calantone (1990) created the comparative marketing Model for international TT based on studies done by Jean Boddewyn (Boddewyn J.J, 1966) (1981). Environment, actors, structure, process and functions are main components of the model. The structure of model is quite intricate, and it hasn't undergone rigorous statistical analysis to provide empirical validation. Furthermore, the model is primarily focused on marketing and logistics, despite the fact that it includes a number of elements that may be modified for use in the building environment. The study found that TT research studies should additionally focus on evaluating causal interactions rather than only looking at the direct impacts of selected components and related variables.

Ghanian Model

(De-Graft OWUSU-MANU et al., 2017) proposed a conceptual model for the Technology transfer process in the Ghanaian construction sector is to include all pertinent elements that affect TT's efficacy, and the value added that results from it. Several factors were discovered through the contextualization, classification, and conceptualization of variables' relationships with one another. These elements were categorized as TT value-added elements and enabling elements. Characteristics of transferor and transferee, transfer environment, relationship building and absorptive capacity, government influence, learning environment, communication, project performance and knowledge advancement are the eight factors of classification of variables.

Value Added Model

Waroonkun and Stewart (2007) have proposed provide a guidance which fulfill most of the aspects of enablers of TT and value creators. Thai architectural, engineering, and construction (AEC) businesses are referred to as the transferee, while international AEC firms that collaborate with Thai firms to get projects are referred to as the transferor. Transferor companies were founded in industrialized countries including the United States, Japan, and Germany. It can highlight the positives and negatives of TT accomplishment. The proposed Stewart and waroonkun (2007) guidance has seven aspects. The transfer environment and learning environment are the first two enablers of the guidance. Characteristics of foreign experts (transferor) and characteristics of local experts (transferee) are the other two enablers of the guidance. The successfulness of above four aspects of enabler's in TT project make value creations to transferees country. The financial growth and expansion of knowledge base in host country are two main value creators. The project performance is the other value added for the construction industry.

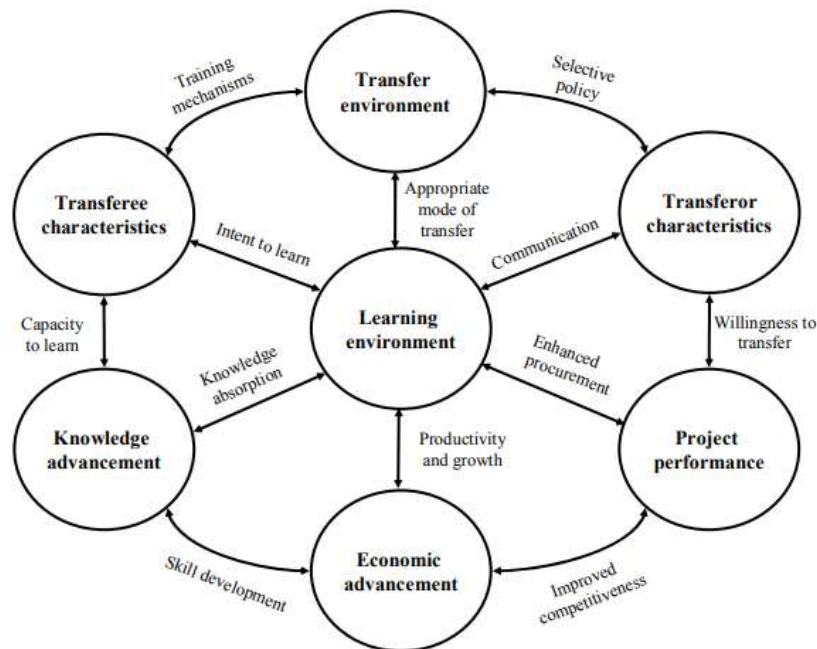


Chart: 2.1 Seven proposed perspectives by (Stewart,waroonkun, 2007)

2.3.1 Transfer environment

The nature of technology used for the TT project, type of transfer are first two parameters of this aspects. The important other aspects are government regulations and enforcement of government rules. In total, four sub factors are included in the aspect of Transfer environment

- **Construction technology**

Simkoko (1992) explained that local experts will not be able to catch up the technology if it more advanced than the existing working technology. The expected outcome will not be able to achieve. Therefore it is mandatory to transferred technology shall be absorbable to local experts with intention to reuse in future projects.

- **Mode of transfer**

Calantone at al (1990) , explained that the mode of TT is most important parameter of TT process. This will define the authority of local experts who working on the projects and it has a great impact on achieving TT objectives. This can be defined as the vehicles of TT process. Joint venture agreements, Sub Contracting agreements are main modes of TT.

- **Government policies and practices for enforcing them**

Calantone at al (1990) explain that government regulations and practices including enforcements will define the outcome of TT process. Especially foreign policies on international trade has a great impact on attraction of foreign companies with their technologies. Kumaraswamy at al, (2002) stated that such policies should encourage foreign companies to work with local companies. Ofori, (2000) express that incentive to transferors will be highly effective to encourage them.

2.3.2 Learning environment

According to Fisher et al., (2001), the status of relationship between foreign and local experts is a major concern on TT process objectives. Kumaraswamy and Shrestha, (2002) shows that link language used is also important for the objectives. Lin and Berg, (2001) explained that quality of training programs is critical in the aspect of learning environment in TT process. Black et al. (2000) and (Malik, 2002), stated that the effective communication is essential to build a strong relationship with mutual trust between foreign and local experts. Black et al., (2000) and Devapriya and Ganesan, (2002) mentioned that strong commitment from senior executives for both transferor and transferee is essential to grow that culture. Black et al., (2000) further stated that previous experiences of both parties in TT projects will end up in strong learning environment. According to Saad et al., (2002) and Simkoko, (1992), well arranged and managed training courses implemented under the TT projects has a high potential in TT to local industry.

2.3.3 Transferor and transferee characteristics

The characteristics of the transferor and characteristics of transferee are other two aspects of enablers. Kumaraswamy and Shrestha, (2002), explained that the attributes of transferor and transferee determine the level of TT process. Malik, (2002) stated successful TT can be achieved when transferor is prepared to pass on the absorbable technology and the transferee is ready to accept it at the same time. According to Berg and Lin, (2001), the extent of international experience of both parties (transferor and transferee) together with the essence of the experience can impact immensely on the process of TT transfer. Saad and Wang (Saad et al., (2002) and Wang et al., (2004), explained that the ability to pass on and acquire technology is also count on extent of transferees and transferors knowledge gap. Kumaraswamy and Shrestha, (2002), Fisher and Ranasinghe, (2001), Wang et al., (2004) further explained that it is important to evaluate the characteristic of ethnicity of the transferor and transferees prior to take up on the TT process.

2.3.4 Economic advancement

According to (Benedetto, C.A.D, Calantone, R.J,Zhang, C, 2003) and Fisher and Ranasinghe, (2001), improvement of living standards and economic prospects are main objectives of encouraging TT by the governments of developing countries. It can be achieved only if workers from host's end and professionals work on a level higher than usual and achieve to be much competitive in the markets both domestic and international. It is noted that the advancement in economy is a factor slowing down the rest of the aspects, and that it will typically occur in the far away course when the knowledge that was transferred has been taken and used on projects in the hosting country.

2.3.5 Knowledge advancement

According to Cordey-Hayes and Gilbert (1996), going beyond the revenue producing economic benefits that comes from host ventures can experience knowledge enhancement at the personnel and bureaucratic level. The preliminary outcome of programs of TT is transferring of the tacit and implicit knowledge to workers on the host end. If this knowledge is accepted it should also be accepted practice for a distance future.

2.3.6 Project performance

According to (Chua, D.K.H., Kog, Y.C , Loh, P.K., 1999), Devapriya and Ganesan, (2002), Improvement of financial performance, schedule performance and quality performance of construction projects result from effective technology transfer. This perspective is concerned with the impact of TT programs on the performance of Construction projects and this examines any improvements in the performance of financial, schedule and quality indicators.

CHAPTER 3 – RESEARCH METHODOLOGY

3.1 Research approach

This research made use of quantitative research strategies to evaluate the degree of technology transferred to the local professionals through the New Kelani Bridge Construction Project. Data gathering for the research was done from Sri Lankan experts who involve with New Kelani Bridge project representing the Contract package 1 and 2 contractors, Consultants and the Client. A questionnaire was used to collect data from respondents to collect quantitative data.

3.2 The Sample

The number of local professionals selected for the sample by applying random sampling theory and stratified sampling theory. It was thought that a population of 200 professionals (Local) worked in New Kelani Bridge Project. A sample of 50 was selected as the target population out of the estimated population. 50 surveys were disseminated and out of those, 47 returned with a response rate of 95%.

3.3 Questionnaires

The questionnaire which comprises of 29 questions to represent all the aspects in the hypothetical model proposed by Stewart and Waroonkun (2007) has been used for respondents to collect quantitative data. In total, 50 questionnaires were distributed covering all professionals of project participants such as project client, consultants and contractors and 47 were returned. Three sections were contained in the questionnaire.

There are three sections in the questionnaire. The first section of the questionnaire consists of descriptive statistics of participating respondents such as experience, description of position and project profile of TT (i.e: mode of transfer, type of transfer and value). The subsequent section comprises of questions focused at enabling forces of transferring environment, transferor characteristic, learning environment and characteristics of the transferee for successful transfer of

technology. The outcome of economic advancement, knowledge advancement and project performance were measured in the section 3 of questionnaire. Both section two and three have questions focusing all variables in the hypothetical model.

The significance of each variable for TT was measured from the respondent's ratings. A five point Likert scale was used to measure the ratings of respondents ranging from strongly negative (1) to strongly positive (5) for perception of successfulness of TT factors in New Kelani Bridge Project. As an example, the participants were asked to rate success of mutual trust in the project.

3.4 Reason for selection of the methodology

Many studies have used qualitative methods to assess the technology transfer in the construction sector, but relatively few of them used qualitative methods. In studies of this kind that used qualitative research, face to face interviewing has proven to be the most dependable and productive mode of data collecting method. However, Interviewing is neither practical nor cost-effective when there is a lot of data to manage. Furthermore, the anonymity or privacy of such discussions would be a significant disadvantage because some responders could be hesitant to provide personal information. Above all, the interviewer's skill will determine the caliber of the information acquired. The interviewer's communication abilities should be top-notch in order to collect objective, trustworthy, and correct data.

Therefore, quantitative research strategies were used to quantify outcomes in numerical terms that are simple for decision-makers to grasp and comprehend. These quantitative findings were obtained through a questionnaire with a sizable sample of persons who represent the target population. Therefore, statistical analysis could be used to measure the degree of technology transfer in the road construction industry.

The model proposed by Stewart and Waroonokun was chosen over the other concept models mentioned in the literature review section because it is applicable to Asian developing countries and because it captures all variables that impact the degree of technology transfer. The questioner was prepared according to the proposed model by (Stewart,waroonokun, 2007)

3.5 Data Analysis

The analysis of collected data was done in detail such as classification of respondent's profile and their rating for each technology transfer performance indicators in the questionnaire. The results were summarized in chapter 4.

The classification of respondent's profile was done based on their nature of work related with project, highest education level, and professional experience in related field and designation level in the project. The results of the data are presented in the formats of charts and comparison graphs. This ensures that respondents were educated adequately enough to formulate a professional opinion about Technology Transfer (TT) and the field of construction.

Participants were requested to rate each indicator of TT performance. The analysis of the data collected through questionnaires took place via thematic analysis. Since the sample is small the researcher did not use any of the statistical softwares similar to "Statistical Package for the Social Sciences" (SPSS) for analysing data. The findings of the interviews were also analysed manually.

The mean value and the standard deviation values for main factors and sub-factors are calculated. The mean value for construct score of the main factors are computed by weighting the mean scores of the subfactors. Comparative analysis was carried out among the project participants against the main factors and subfactors. Benchmark value for each aspect and overall score were determined according to the (Stewart,waroonokun, 2007) method.

3.6 Ethical consideration

There were several types of ethical issues which were the researcher had to take into consideration for the research. The most important one was related to the informed consent of the respondents. All of the respondents were duly informed in advance about the purpose of the research.

The second was all the information/data collected in the course of this dissertation has been used only for the purpose of the research and will be kept confidential.

3.7 Limitation of the study

Several challenges were experienced while conducting the study, such as; some respondents were not adequately cooperative with the encounters in collecting data due to following reasons:

- Professionals directly involved with the project were contacted for the questioner.
- Suspicions on confidentiality of data.
- Negative attitudes towards research work.
- Unwillingness to disclose their correct views.
- Reluctance to spend time on responding the questioner.

CHAPTER 4: ANALYSIS OF DATA

4.1 Nature of business of your company affiliation with the project

The below Chart No 4.1 shows the nature of business of respondents with the project. As per the results of the study, it was revealed that the highest percentage of 53% represents in Contractors both package 1 and package 2. 13% and 34% represent from Client and Consultant respectively. It ensures that collected data represents actual professional involvements with project. This made up a comprehensive respondent profile.

Nature of business		No of respondents %
Client		13%
Consultant		34%
Package 1	15%	53%
Package 2	38%	
Total		100%

Table 4.1: Nature of business of respondents

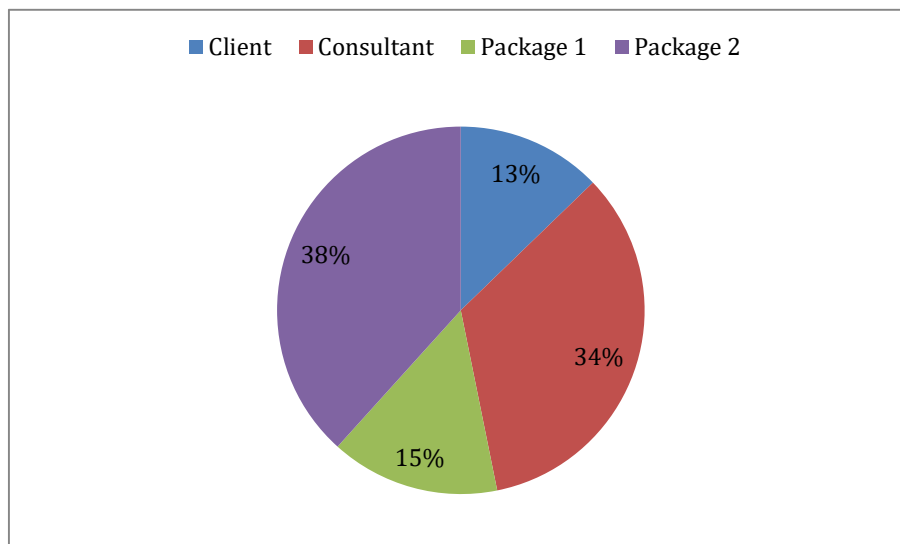


Chart 4.1: Nature of Business of respondents

4.2 Level of education of respondents

The below Chart 4.2 depicts the level of educational qualifications of respondents. It was revealed that highest number of the participants had a Bachelors Degree (51%) levels and no respondents had PhD level education. Masters degree and diploma and other qualified respondents were 28% and 21% respectively. It ensures that respondents were people who were educated adequately enough to formulate a professional opinion about TT and the field of construction.

Type	Highest Education Qualification			
	No of respondents			
	Bsc	Msc	Phd	Dip & Other
Client	50%	50%	0%	0%
Consultant	63%	25%	0%	13%
Package 1	14%	43%	0%	43%
Package 2	56%	17%	0%	28%
Total	51%	28%	0%	21%

Table 4.2: Level of education of respondents

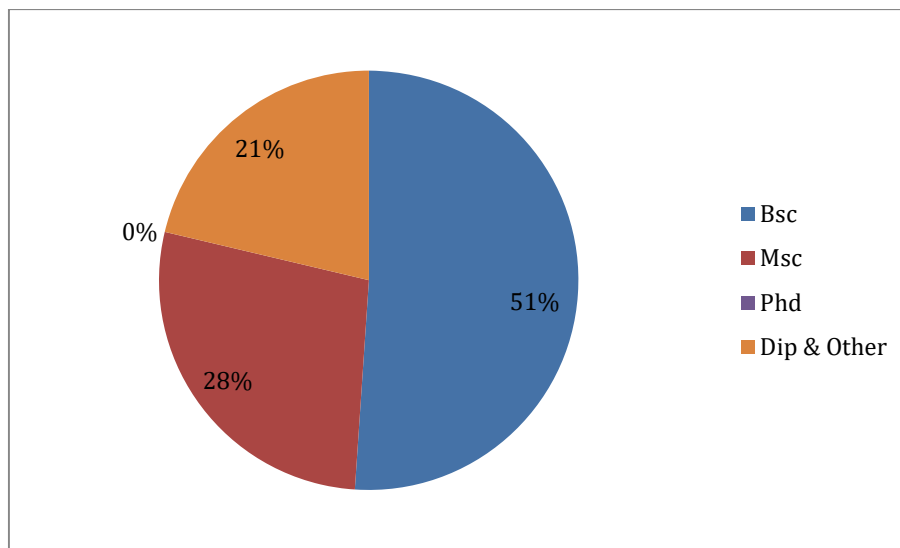


Chart 4.2: Level of education of respondents (Overall)

It was further revealed that most of the respondents of package 1 were Master degrees and diploma or other qualified professionals.

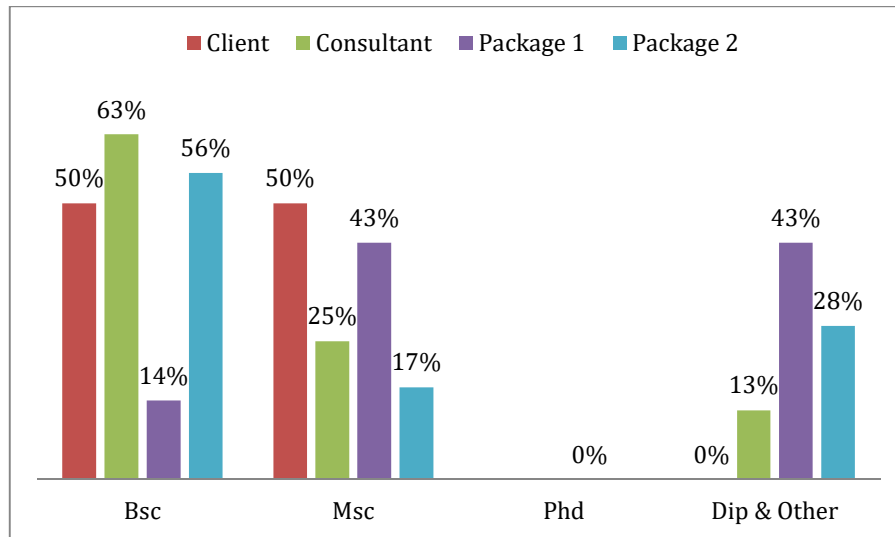


Chart 4.3: Level of education of respondents

4.3 Experience in relevant field

The construction experiences of respondents are tabled below and the highest percentage of 55% of respondents had more than 10 years' experience. This situation was advantageous to collect more accurate data for the research. It ensures that collected data represents actual professional involvements with project. This made able the establishment of a very descriptive profile of respondents.

Type	Experience in relevant field		
	No of respondents		
	0-5	5.-10	More Than 10
Client	0%	33%	67%
Consultant	0%	19%	81%
Package 1	14%	14%	72%
Package 2	44%	33%	23%
Total	19%	26%	55%

Table 4.3: Experience in relevant field

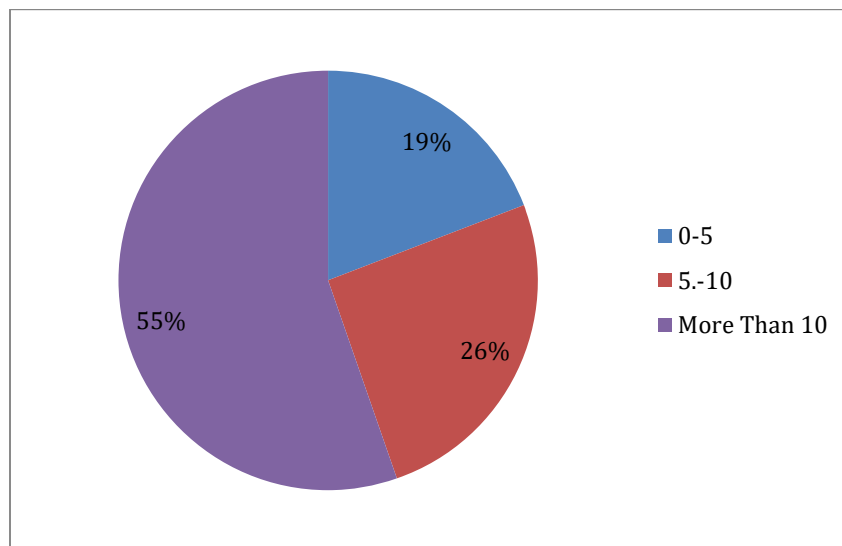


Chart 4.4: Experience in relevant Field (Overall)

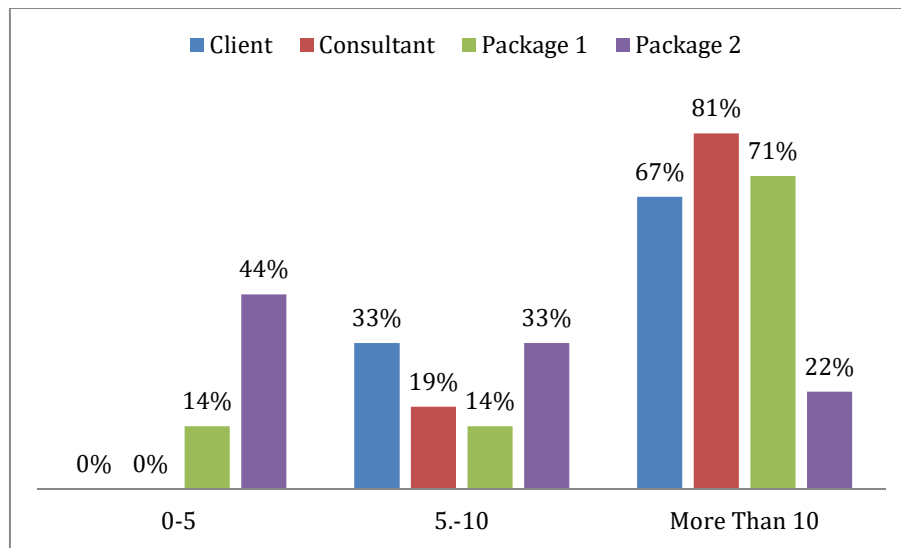


Chart 4.5: Experience in relevant Field

4.4 Designations of Staff

As shown in Chart 4.6, above 53% of the respondents are categorized as junior level professionals in the projects. It ensures that collected data represents actual professional involvements with project. This made able the establishment of a very descriptive profile of respondents.

Type	Designations of staff		
	No of respondents		
	Senior Level	Middle Level	Junior Level
Client	17%	33%	50%
Consultant	13%	63%	25%
Package 1	14%	43%	43%
Package 2	0%	17%	83%
Total	9%	38%	53%

Table 4.4: Designations of Staff

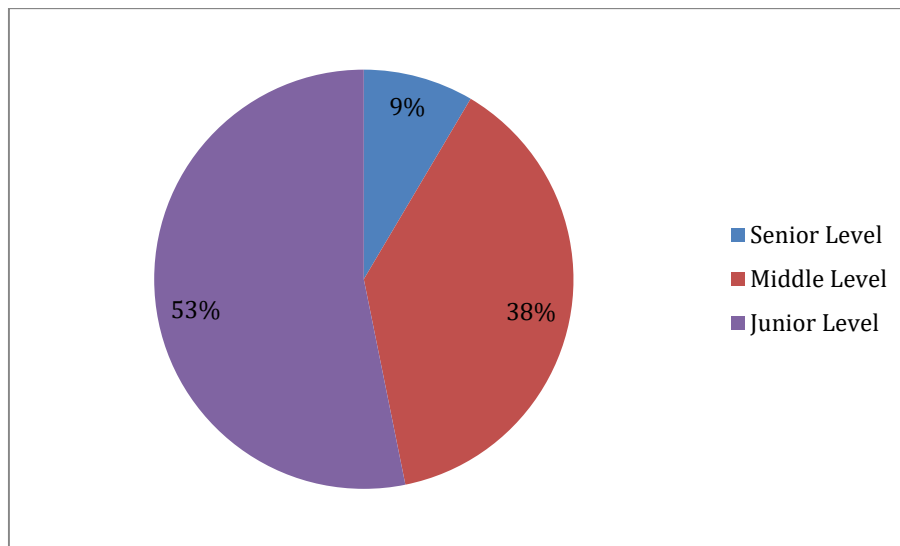


Chart 4.6: Designations of Staff (Overall)

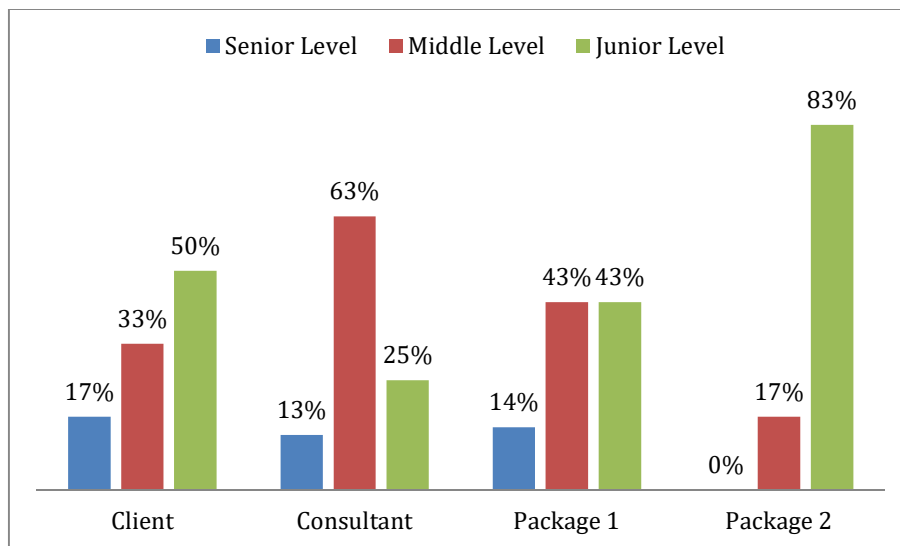


Chart 4.7: Designations of Staff

4.5 Technology Transfer performances

The method proposed by Stewart and Waroonkun (2007) was utilized to describe this case study. However original perspectives were considered for this study. Aspects that represented the enabling sources and outcomes of the process of TT were, Transfer Environment; Learning Environment; Transferor Characteristic; characteristics of the transferee; advancement of the economy; advancement of knowledge; and performance of the project.

The statistical calculations for main and co factors are detailed on Table 4.5 of Annex A. The mean value for construct score of the transfer environment (TE) is calculated using the mean values of the complexity of technology in construction work (TE1), mode of transfer (TE2), government policy (TE3) and enforcement by government (TE4) equally.

The most significant outcomes of this study are as follows:

Based on their ratings, the respondents rated learning environment (LE) as being the most successful enabler (3.88). Adversely, they thought that the transfer environment (TE) was the lowest performing enabler (3.62). Transferor characteristic (TR) was the second lowest performing enabler (3.70). Dealing with government enforcement (TE3) and government policies (TE4) had the lowest success values (3.15) and (3.26) respectively. It seems that transferee has no problem with the complexity of construction technology but the government policies and government enforcement. They expected government policy and enforcement to be improved in order to transferor to implement such programs to transferee.

Based on their ratings, the respondents rated Economic Advancement (EA) as being the most successful value creation (4.07). Counteracting to that, they thought that the Project Performance (PP) was the least performing value creation (3.92). Knowledge

Advancement (KA) was the second highest performing value creation (4.04). Quality performance (PP3) was rated as the most effective (4.30) variable and it is proven considering the output of the project.

Overall, the participants stated that Technology Transfer was making moderate to high value for host sector. Further they also believe in Technology Transfer initiatives being providing massive contribution for improvement financially and knowledge outcome for their firms.

4.6 Comparative Analysis

The transfer environment (TE: 3.99) was the highest scoring factor for contract package two (Table 4.5). Out of all the sub factors evaluating the transfer environment, complexity of technology (TE1) was most highly rated for contract package two (4.61). This results confirms that the complexity of construction in contract package 2 which is absorbable to local professionals is caused to improve TT process compare to others. For all the co-factors evaluating the Transfer Environment, transferring mode scored as the second highest in Contract Package two (4.22). This results confirms that the mode of transfer of contract package 2, i.e. making joint ventures with foreign and local companies is caused to improve TT process comparing to other modes.

The Learning Environment (LE: 4.42) was the highest of contract package two (Table 4.5). For all co-factors evaluating the connection amongst the transferee and transferor in this process of TT, Culture, trust, communication, team work, commitment, training, subcontractors and supervision were rated as the highest for contract package 2. This result indicates that the transferor and transferee of contract package 2 had a good relationship which supports for a highly uniform and knowledgeable approach to TT process comparing to other project participants.

The characteristics of the transferor (TR: 4.38) were the highest for company two (Table 4.5). From all the other factors describing the characteristics of the transferor, knowledge base was most highly rated in contract package two (4.67). This acts as evidence for the fact that the level of knowledge of the party of transferor's base working with organizations from different countries is very important to improve the process of TT, and also that the transferor's party that worked together with the second contract package had the highest extent of knowledge compared to other project participants.

The transferee characteristics (TE: 4.10) was the highest scoring factor for the second contract package (Table 4.5). For co-factors evaluating transferee characteristics, the willingness of the transferee to learn and transferee management were rated the highest and the same for contract package 2 (4.28). These results show that the willingness to learn and transferee management is important for developing eagerness to get to know the components of technology together with the host's side of professionals who were involved in contract package 2 had the willingness to learn and transferee management.

The advancement of economy (EA: 4.39) was the highest scoring factor in second contract package (Table 4.5). For other factors evaluating the advancement of economy, the performance of the transferee was rated the highest in contract package 2 (4.50). This provides evidence for the fact that the transferee performing at a higher standard contributes to the growth of the economy in the hosting country, and also the fact that performance of these local professionals involved in Contract Package two had hugely improved during this period of TT.

The increase of knowledge base (KA: 4.35) was the highest scorer for the second contract package (Table 4.5). For co-factors evaluating the advancement of knowledge, enhanced knowledge was stated as the highest for second contract package (4.72). These results demonstrate that the adoption of knowledge in

construction is pretty much necessary to improve knowledge base. Therefore, transferee's team who worked with second contract package had broadened their knowledge in terms of modern and novel technologies.

The performance of the project (PP: 4.41) was the highest scorer for second contract package (Table 4.5). For co-factors evaluating the project performance, improving the quality performance was rated the most for contract package two (4.72). This result confirms that the effectiveness of TT between transferors and transferees has enhanced the quality performance of local professionals and companies.

4.7 Benchmarking of performance of technology transfer

The benchmark value for each aspect and overall score were determined as per the method described in Stewart and Waroonkun (2007). The seven enabling and outcome aspects were used as a framework to provide a benchmark of the effectiveness of new bridge construction project. The mean values for each indicator was utilized to create wholistic weights for each and every indicator in the framework. The mean values for each indicator were then multiplied by global weights to create individual perspective scores and an overall score, respectively. The details of each global weighting, resultant scores of performance for each aspect and the overall index for TT for the new Kelani bridge project is summarized below. Each one of these bench marking calculations together with the implications of results will be discussed in the next sections.

Determining global weights

The world- wide relative weights of perspectives contribution to overall TT index were determined according to the method of Stewart and Waroonkun (2007) such that transfer environment (TE) and transferor characteristics (TR) perspectives (20%), transferee characteristics (TC) and leaning environment perspectives (LE) (15%) and the rest of the aspects each had an importance scoring of 10%.

Technology transfer score and Index

To give a baseline reference on the performance of transfer of construction technology in New Kelani Bridge Project, a value was calculated for every aspect of the frame and an overall index TT. These scores were then calculated by average of mean value of each of the pointers were within a perspective of the framework (i.e. TE = 3.62 or 72%).

The blanket index of TT was calculated by adding up multiplication of perspective score against the global relative weight for respective each perspective (i.e. TT index = $3.62 \times 0.2 + 3.88 \times 0.15 + 3.7 \times 0.2 + 3.84 \times 0.15 + 4.07 \times 0.1 + 4.04 \times 0.1 + 3.92 \times 0.1 = 3.82$ or 76%). A statement score of 76% implies that construction TT pursuit in New Kelani Bridge Project have been operating very effectively.

On the other hand, this outcome also shows the fact that there is more room for improvement. It has to be made clear that this rating gives a much holistic approach on performance of TT by capturing both enabling the process (i.e. TE, TR, LE) and outcome (PP, EA, KA) aspects. Chart 4.8 gives clues on less performing elements in the value creation process of TT. Results of each of these perspectives have ranged from 72-81%. The most scoring aspects were the outcome perspectives, advancement of the economy (81%), advancement of knowledge (81%) and the project performance (78%) suggests that Sri Lankan economy would achieve advantages of technology development from this construction project.

Values for transferor characteristics (74%), transferee characteristics (77%), learning environment (78%) and transfer environment (79%) aspects were also high, which shows that the Sri Lankan professionals enrolled in the New Kelani Bridge Project were happy with their own values and their foreign partner's values in addition to the relationship between the two parties.

Adversely, lowest performing aspect was transfer environment (72%) suggest that government can formulate a more receptive TT policy which would encourage or dictate TT arrangements and transfer modes, which will in the end promote more productive international oriented relationships.

Figure 3 Chart 4.8, gives clues to underperforming elements in international process of TT for each company. Specially, this figure represents the performance wise TT scores for the seven aspects (i.e: TE,LE, TC, TR, FA, PP, and KA) for this study.

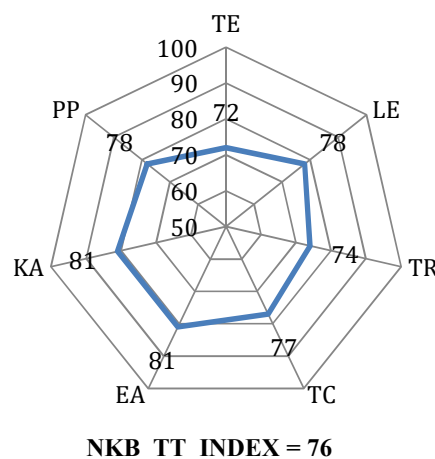


Chart 4.8: NKB TT INDEX

Comparative Analysis

Benchmark scores (TT index) for project participants such as Client, Consultant, Contract Package 1 and 2 extend from 62 to 85 per cent. This shows that all construction companies from host's end who are engaged with the previously done case reports depicted the process of TT in construction, as operating effectively at a moderate to high scale. Furthermore, these results also show that there is more room for improvement.

In Chart 4.12, describing contract package 2, the highest percentage of 88% was gained for the perspective of learning environment. 87% was scored for the transferor characteristics, transferee characteristics scored 82% and transfer Environment scored 80%. Therefore, these perspectives were also quite high. This points towards that Sri Lankan professionals in construction working together with contractors of package 2 were happy with their own qualities, the qualities of the foreign partner and the relationship between both parties. Furthermore, the outcomes wise, advancement of economics (88%), advancement in knowledge (87%) and project wide performance (88%) depicts that economy of Sri Lanka would gain advantages of development of technology from this construction project.

In Figure, Chart 4.11, contract package 1, the highest scores for the characteristics of transferee which accounted to 80% provides evidence that professionals from Sri Lanka were reasonably satisfactory with their own gains. Values for learning environment (77%), transfer environment (73%) and transferor characteristics (73%) indicate that Sri Lankan professionals in construction industry were happy with foreign partners' perspectives and they built up effective work relationships with these partners. The outcome aspects of advancement in economy (81%) and advancement of knowledge (83%) depicted that this project should bring advantages for the economy of Sri Lanka. Furthermore, it is worth mentioning that the Sri Lankan construction field professionals were highly happy with the improvement of their knowledge in the methods of construction work, working practice of that time and the use of technology. The project performed better in the aspects of project performance scoring 77%.

According to Chart 4.10, Consultant, The highest value was obtained for learning environment perspective (72%). Transferee characteristics perspective (70%) indicating that Sri Lankan professionals in construction field were quite happy with their own values. The scores for transferor characteristics and transfer environment were relatively low being 64% and 68% respectively. The professionals in this rated

satisfaction, as being low when considering the foreign partners' values and about the ability to make effective relationships with these foreign partners. Considering the outcomes, advancement in the economy (83%), and advancement of knowledge (79%) and performance of the project (76%) were valued reasonably adequate. This suggests that the host construction sector with its employees would gather some gains from the project.

According to chart 4.10, client, highest scores for transferee characteristics (69%) indicates the fact that Sri Lankan professionals in construction field who are enrolled in this construction work were quite pleased with their own values. Characteristics of the transferor (59%), Learning environment (61%) and Transfer environment (62%) indicate that Sri Lankan professional workers recorded less satisfaction with foreign partners' values and the ability to make effective qualitative relationships with the foreign partners.

The advancement of economy which scored 60% indicates that this project is hoped to achieve further advantages for the economy of Sri Lanka. The other outcomes such as, knowledge advancement (63%) and project performance (58%) scored in the middle range, indicating that professionals from Sri Lanka were satisfied with enhancing their knowledge to further improve their working practice. This project showed comparably better performance when considered the perspective of schedule performance.

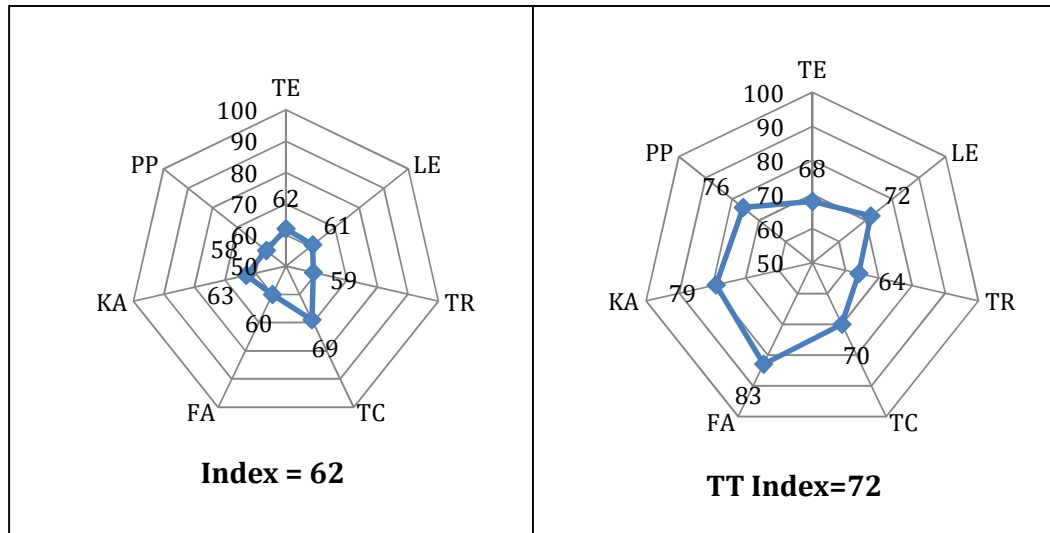


Chart 4.9: Client TT Index

Chart 4.10: Consultant TT Index

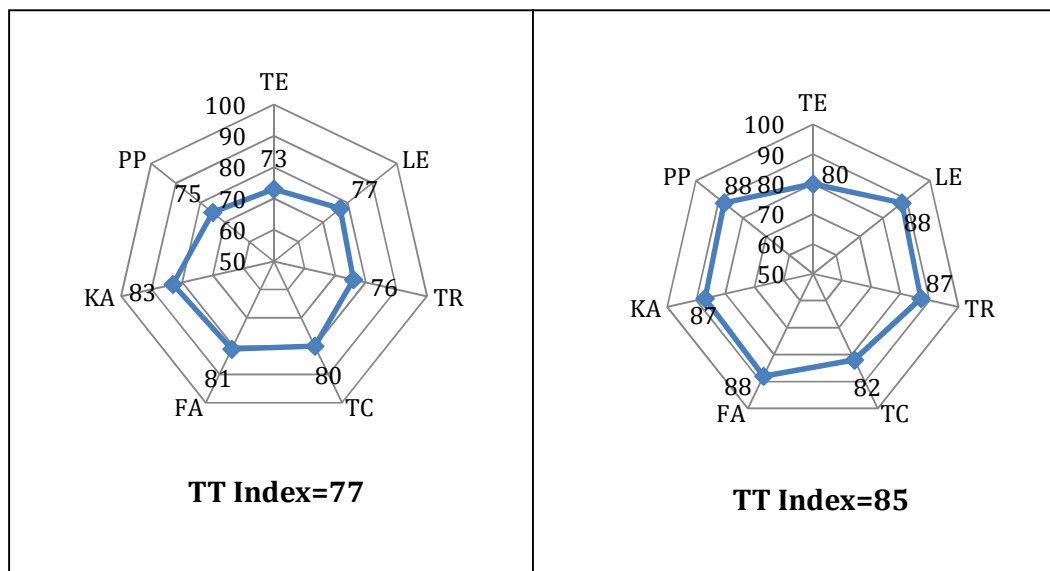


Chart 4.11: Package 1 TT Index

Chart 4.12: Package 2 TT Index

Furthermore, this spider diagram describes how the second Package of NKB was seen as one of the most effective projects for transferring of construction technology.

Especially, the contract package 2 achieved higher scores in every perspective. However Client of NKB has achieved lowest score compare to others.

4.8 Identified main issues in TT of NKB

As per the responses, the following main problems were identified under the underperforming perspectives in implementation in technology transfer through this project.

TE: Transfer Environment

- The mechanism in the contract to transfer the technology and government enforcement are not adequate.
- Transportation or production cost of machineries used during technology transfer is very high.

LE: Learning Environment

- Understanding of the cultural differences between internationals which eventually lead or fail to build the trust.
- Communication difficulties of both foreign and local professionals.
- Inadequacy of trainings sessions such as experienced shared by the foreign professional through short presentations only.
- Lack of opportunities for junior engineers to have hands-on experiences.

TR: Transferor Characteristic

- Authority and responsibility delegation to local professionals was limited. Local professionals were mainly utilized and limited to site management, overseeing and managing construction activities and labor management whereas knowledge transfer on the bridge design and other new techniques was withheld by the foreign professionals.
- The accessibility to technical resources was limited such as even the design calculations are not shared with the staffs.

TC: Transferee Characteristic

- The inputs of local professionals at the design stage were not adequate.
- Poor commitment of local's professionals to improve such that the existing technical knowledge in locals is different than what the foreign expertises have, so they had to spend a little time to learn and adjust.
- Poor recognition by local management of trained locals such as no motivations.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Sri Lankan government annually spends billion rupees into road infrastructure projects with the assistance of international financing agencies. The one of the main objective on investing that money is to transfer advanced technologies to the Sri Lankan construction industry apart from essential road infrastructure. The Technology Transfer has been in effect in Sri Lanka for years but there was no systematic approach to monitor and evaluate the effectiveness. The New Kelani Bridge is one of recent project which had taken initiatives on technology transfer. The benchmarking method was implemented to evaluate the effectiveness of technology transfer of project. This could identify underperforming perspectives, processes in order to redeveloping them using best practice for continuous improvement.

The benchmark score of 76 percent was determined implying high effectiveness in TT. The results of considered perspectives show that the Sri Lankan economy would gain advantages in technology development from this construction project. Sri Lankan professionals working in the New Kelani Bridge Project were satisfied with their own characteristics and their foreign partner's characteristics together with their relationship with the foreign partners. Comparative analysis determined that Sri Lankan professionals and companies engaged with client, consultant and package one and Package two have been operating moderate to highly in the efficacy.

The Package two had the highest TT index score of 85 percent. This package was mostly effective in transferring technology to Sri Lankan construction industry. The high TT index score of this study Package 2 may have resulted from the following main aspects: (1) Main contractor, SMCC has been the pioneers of extradosed bridge construction work for years and had been working in developing countries with TT processes (2) Extradosed Bridge section was engaged with highly complex construction technologies but understandable to local professionals. (3) Most of construction work were carried out on site (Within Sri Lanka) and (4) SMCC made a

joint venture agreement with SANKEN (Sri Lankan Firm) as SMCC-SANKEN JV where local professional had higher authority as well as opportunities.

The Package 1 (JMT JV) had the second highest TT index score of 77 percent. Relatively higher TT index score for Package 1 may have been the result of the following main factors.

(1) JMT has been a pioneer in steel bridge Construction for years and had been working in developing countries with TT processes (2) Steel Bridge section was engaged with highly complex construction technologies. In comparison to contract package 2, relatively lower index may have result due to following factors (1) Steel fabrication works were carried out in overseas countries and only steel erection works were carried within Sri Lanka. (2) JMT had no joint venture agreement with Sri Lankan companies but subcontracting works only. Therefore involvement of Sri Lankan professionals and companies was limited and restricted.

Consultant (OC KEI JV) had the third highest TT index score of 72 percent. Relatively higher TT index score for Consultant may have been the result of the following major factors.

(1) OC KEI JV has been the pioneers of design and supervision of highway infrastructure Construction work for years had been working in developing countries with TT processes. In comparison to contract package 1 & 2, relatively lower index may have result from the following factors (1) Most of design works was carried out in overseas countries. (2) JMT had no joint venture agreement with Sri Lankan companies but associations which has less authority for local companies. Therefore involvement of Sri Lankan professionals and companies was limited and restricted.

Client had the lowest TT index score of 62 percent due to limited involvement of professionals on technology transfer process. Even though they had the highest authority, it seems that there is no proper mechanism for TT process except the arranged foreign and local trainings.

5.2 Recommendations

According to literature and on the basis of the results of the study, the recommendations are suggested to improve the following underperforming perspectives in implementation of similar technology transfer projects.

Transfer Environment

- Encouraging foreign companies to make more joint venture arrangements with Sri Lankan Road construction companies to work in Sri Lanka and also to establish partnerships to carry out several projects in the country.

Learning Environment

- Make it compulsory for foreign professionals to have trainings and knowledge transfer sessions with a separate item in the BOQ or evaluation-based monitoring system.

Transferee Characteristic

- Encouraging and collaborating more Sri Lankan Road construction companies with foreign companies to learn their technologies.
- Encouraging local companies to give more opportunities for young engineers to be involved in major projects.

Transferor Characteristic

- Encouraging foreign companies to bring their technology and setup their workshops with machineries in Sri Lanka and get local people trained under their supervision.
- Reviewing and evaluation of government enforcements on technology transfer perspectives on projects.
- Conducting performance evaluation, fixing targets, recognizing the trained ones, motivations after training.

5.3 Future Research

The analysis results and recommendations are strictly based on this case study only. This can be more detailed and verified with future research with more foreign funded road construction projects in Sri Lanka using the same framework. This framework can be modified for more accurate results with future research.

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Appendix A: Summary of TT Evaluation

	Description	Client		Consultant		Package 1		Package 2		Overall	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Enablers	Transfer Environment(TE)	3.08	0.79	3.41	1.17	3.64	1.21	3.99	0.84	3.62	1.06
	Complexity of construction technology	3.67	0.82	3.94	1.09	3.86	1.07	4.61	0.61	4.15	0.96
	Mode of Transfer	3.33	0.52	3.76	1.09	4.00	1.00	4.22	0.81	3.91	0.95
	Government policy	2.83	0.98	3.06	1.30	3.29	1.38	3.56	1.04	3.26	1.19
	Government enforcement	2.50	0.84	2.88	1.22	3.43	1.40	3.56	0.92	3.15	1.14
	Learning Environment	3.06	1.03	3.59	1.25	3.86	0.91	4.42	0.78	3.88	1.12
	Culture	2.67	1.21	3.47	1.33	3.71	1.25	4.44	0.86	3.81	1.24
	Trust	2.50	1.05	3.47	1.23	3.43	1.40	4.39	0.78	3.72	1.21
	Understanding	2.83	0.75	3.82	1.01	3.71	1.11	4.56	0.70	3.98	1.03
	Communication	3.00	1.10	3.65	1.27	3.43	0.79	4.56	0.62	3.87	1.12
	Commitment	2.83	1.17	3.76	1.25	4.29	0.76	4.72	0.46	4.06	1.11
	Team Work	3.17	0.98	3.71	1.21	4.00	0.58	4.28	1.02	3.89	1.09
	Training	3.33	1.21	3.29	1.40	3.86	0.69	4.39	0.98	3.79	1.23
	Local Subcontractors	3.33	0.82	3.41	1.28	4.00	0.82	4.00	0.97	3.68	1.07
	Supervision	3.83	0.98	3.76	1.25	4.29	0.76	4.44	0.62	4.09	0.97
	Transferor Characteristic	2.96	0.94	3.22	1.13	3.79	1.44	4.38	0.78	3.70	1.18
	Willingness to implement	2.83	0.98	3.06	1.30	4.00	1.41	3.94	1.16	3.47	1.28
	Degree of experience	2.83	0.98	3.35	1.06	3.86	1.57	4.39	0.78	3.72	1.16
	Transferor Management	2.83	0.98	2.94	1.14	3.57	1.40	4.50	0.71	3.62	1.24
	Knowledge Base	3.33	0.82	3.53	1.01	3.71	1.38	4.67	0.49	3.98	1.03
	Transferee Characteristic	3.46	0.54	3.51	1.07	4.00	1.07	4.10	0.89	3.84	0.95
	Willingness to learn	3.50	0.55	3.53	1.28	3.86	1.21	4.28	0.96	3.89	1.09
	Degree of experience	3.50	0.55	3.53	1.07	4.00	1.00	3.94	1.00	3.79	0.95
	Transferee Management	3.33	0.52	3.41	1.00	4.14	1.07	4.28	0.83	3.87	0.95
	Knowledge Base	3.50	0.55	3.59	0.94	4.00	1.00	3.89	0.76	3.79	0.81
Value Creation	Economic Advancement	3.00	1.32	4.18	1.07	4.07	1.02	4.39	0.97	4.07	1.12
	Competitiveness	3.17	1.47	4.12	1.05	4.00	0.82	4.28	1.02	4.02	1.09
	Performance	2.83	1.17	4.24	1.09	4.14	1.21	4.50	0.92	4.13	1.15
	Knowledge Advancement	3.17	1.02	3.96	1.09	4.14	0.79	4.35	0.81	4.04	1.01
	Improved Knowledge	3.33	0.82	4.18	1.13	4.00	0.58	4.72	0.57	4.28	0.93
	Improved working Practices	3.67	1.03	4.06	1.09	4.14	0.69	4.50	0.86	4.19	0.97
	Long term adoption of transferred skills	2.50	1.22	3.65	1.06	4.29	1.11	3.83	0.99	3.64	1.13
	Project Performance	2.89	1.10	3.80	1.07	3.76	1.05	4.41	0.72	3.92	1.06
	Financial Performance	2.33	1.21	3.35	1.06	3.29	1.38	4.22	0.88	3.57	1.19
	Schedule Performance	3.00	1.26	3.82	1.07	3.86	1.07	4.28	0.83	3.89	1.07
	Quality Performance	3.33	0.82	4.24	1.09	4.14	0.69	4.72	0.46	4.30	0.91

Table 4.5: Summary of TT Evaluation

Appendix B: Questionnaire for Professionals engaged with NKB Project

Questionnaire

Section 1: Responders Profile

- 1. Organization**
- 2. Designation**
- 3. Nature of Business**
 - Client ☐
 - Consultant ☐
 - Package 1 ☐
 - Package 2 ☐
- 4. Level of Education**
 - Phd ☐
 - MSc ☐
 - Bsc ☐
 - Dip & Other ☐
- 5. Experience in relevant field (Years)**
 - Less than 5 Y ☐
 - 5Y to 10 Y ☐
 - Over 10 Y ☐

Section 2: Enablers: Effectiveness of following factors attributed to TT in NKBP**1 Transfer Environment**

6. TE 1.1 Do you believe that the Complexity Level of used Construction Technologies in the Project was effective to create a good Technology Transfer Environment?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

7. TE 1.2 Do you believe that the Mode of Transfer (Joint venture-Subcontracting-licensing- Associations.etc) was effective to create a good Technology Transfer Environment in the Project ?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

8. TE 1.3 Do you believe that Government Policies adopted in the Project were effective to create a good Technology Transfer Environment?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

9. TE 1.4 Do you believe that Government Enforcement was effective to create a good Technology Transfer Environment in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

2 Learning Environments

10. LE 1.1 Do you believe that Culture between foreign and local professional was effective to create a good learning Environment in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

11. LE 1.2 Do you believe that trust between foreign and local professional was effective to create a good learning Environment in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

12. LE 1.3 Do you believe that understanding between foreign and local professional was effective to create a good learning Environment in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

13. LE 1.4 Do you believe that communication between foreign and local professional was effective to create a good learning Environment in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

14. LE 1.5 Do you believe that commitment of both foreign and local professional was effective to create a good learning Environment in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

15. LE 1.6 Do you believe that Team work between foreign and local professional was effective to create a good learning Environment in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

16. LE 1.7 Do you believe that Training for local professional was effective to create a good learning Environment in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

17. LE 1.8 Do you believe that local joint ventures/sub-contractors was effective to create a good learning Environment in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

18. LE 1.9 Do you believe that Supervision of works was effective to create a good learning Environment in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

3 Transferor Characteristics

19. TR 1.1 Do you believe that foreign professionals are willing to transfer the appropriate technology in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

20. TR 1.2 Do you believe that foreign professionals possessed international experience to transfer the appropriate technology in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

21. TR 1.3 Do you believe that foreign professionals had Management/capacity of this nature to transfer the appropriate technology in this project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

22. TR 1.4 Do you believe that foreign professionals had knowledge base to transfer the appropriate technology in this project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

4 Transferee Characteristics

23. TC 1.1 Do you believe that local professionals are willing to learn adopt technology in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

24. TC 1.2 Do you believe that local professionals possessed relevant experience to adopt appropriate technology in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

25. TC 1.3 Do you believe that local professionals had Management/capacity of this nature to adopt the appropriate technology in this project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

26. TC 1.4 Do you believe that local professionals possessed knowledge level required to utilize the transferred technology in the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

Section 3: Value Creation: Effectiveness of following factors attributed to TT in NKBP

5 Economic Advancement

27. EA1.1 Do you believe that Technology transfer of this project is effective to local professional and companies to become more competitive in the domestic and international market?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

28. EA1.2 Do you believe that Technology transfer of this project is effective to improve the performance of local professional and companies?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

6 Knowledge Advancement

29. KA1.1 Do you believe that Technology transfer of this project is effective to improve knowledge of local professionals?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

30. KA1.2 Do you believe that Technology transfer of this project is effective to improve working practices of local professionals?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

31. KA1.3 Do you believe that transferred technology of this project is becomes a norm over the long Term?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

7. Project Performance

32. PP 1.1 Do you believe that Technology transfer of this project is effective to improve Financial Performance of projects?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

33. PP 1.2 Do you believe that Technology transfer of this project is effective to improve Scheduled Performance of the project?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

34. PP 1.3 Do you believe that Technology transfer of this project is effective to improve Quality Performance of construction projects?

	1	2	3	4	5	
Strongly Negative	☐	☐	☐	☐	☐	Strongly Positive

Other Factors, Problem Encounter and Proposals

35. Please mention any other factors that you think, highly contributed to Technology Transfer in New Kelani Bridge Construction Project?

36. What are the problems encountered in technology transfer through this project?

37. What are your proposals to enhance/improve Technology Transfer in foreign funded Road Construction Projects in Sri Lanka.?