

# Foreign funding construction projects in Sri Lanka: review challenges on Technology Transfer with the local stakeholders

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**Abstract:** *Technology is an integral part of construction and domain factor with cost. Most of modern materials, plant, equipment and services are innovated by developed countries and their aim is to transfer them by one way through funding facilities to other countries. Sri Lankan government pleases to obtain foreign funded in order to develop most of infrastructure and buildings in order to cater for economic growth and living standard which would answer somewhat on socio-economic issues in the present conditions. One of the positive outcomes on foreign funding is the technology transfer. The study aims to define the potential impact on that and assessing them could cater for best decision to do in future endurances. The direct population was stakeholders who are in construction projects and selected sampling (experts) was by snowball technique. The Quantitative and qualitative methods were applied for data collection in the mode of questionnaire and semi-structured interview. The SPSS computer software applied in order to check validation of data and to give reliability of findings. The content analysis had been used for synthesis evaluation.*

*The literature review shows positive effects as well as potential negative effects on foreign technology transfer on other countries as well. The outcome of findings reveal that arrival of modern goods, latest methods of execution, sophisticated computer software modeling and simulating, innovative management procedures as positive impact. The lack of development in supported industry (example, e-commerce in legal trade) and upgrading is required on*

*education on theory and training which derive a negative impact on technology transfer. Finally, the recommendations have been put forward to minimize the potential negative impact areas and identify more opportunities cost on positive impact areas on stakeholders' future projects.*

**Keywords:** *Technology Transfer, impact assessment, economy growth, foreign funding, BIM*

## 1. Introduction

The construction is one of the most important sectors of the economy in any country which creates employments, adding fixed assets in the like of new buildings and infrastructure projects (Khaertdinova, Maliashova and Gadelshina, 2021) which largely depend on investment activities. A developing countries can receive foreign investment through with the basis of aid/grant or borrowing funds in order to enhance socio-economic of the particular society (Golini and Landoni, 2014). Other than this Ijirshar, Godoo and Joseph (2016) shown that construction projects through foreign involvement would facilitate not only a financial assistance but also technical assistance to the local construction team including training, good project management and decision making techniques as well.

Araujo, Alenc, and Mota (2017) stated that foreign finding projects have several unique and uncontroversial features, such as the uniqueness and multidisciplinary nature of the goods and services provided, temporary nature of the undertakings, long life cycles, cost and

quality restrictions, adherence to project management standards, use of advanced tools and techniques, involvement of several stakeholders, provision of community services, cultural differences, and resource scarcity are highlighted as significant circumstance.

With beginning of post-war period, the government of Sri Lanka had planned to proceed construction revolution with the help of foreign donors by US \$ 1.5 – 2 billion a year on road and rail development, power production, port facilities, and water and sanitation in order to achieve a per capita income of US \$ 4,000 by 2016 and reduce poverty and unemployment (Delgoda, 2014). Currently, the contribution of foreign contractors is very high in Sri Lanka. With this situation the process of technology transfer can be increased, and it causes to increase the potential impacts that can happen through the foreign funded projects.

Accordingly, this paper focuses on: (1) discuss how technology transfer on foreign funded projects in developing countries and impacts to the society; (2) identify level of both positive and negative impact on Sri Lankan construction industry and how effect to the stakeholders; and (3) propose suggestions on how and what mitigation action on negative impact and which positive impact would enhance on future funded projects to gain for stakeholders. Having said that this research helps to influential stakeholders to address correctly on decision making when foreign funding project in Sri Lanka.

## **2. Literature Review**

According to Hobbes (2014) and Ika (2015), International Development projects have to facilitate economic growth and poverty reduction through not-for-profit, humanitarian, and socioeconomic objectives. Amarasinghe and Rebert (2018) highlighted that foreign finance is provided to Sri Lanka through traditional donors, non-traditional donors, quasi-governmental organizations (export credit agencies), and sovereign bond sales. The European Union, the USA, Japan, and international development banks are the

traditional donors while the donors that have recently become global financial powers are the non-traditional donors. The literature review has been carried out under the traditional donor funded projects. According to the selected past research documents, the following significant criteria were chosen for further studies.

### *A. Technology Transfer*

Technology Transfer can define as the most valuable concept among world to develop the socio-economic states of a country. Technology can transfer through various ways, among countries, among organizations and more. Luna (2012) defined Technology Transfer as “process of movement of technology from one entity to another” The Technology Transfer process is used by an organization to develop organization’s technology and other related capabilities with the productivity economic concept.

### *B. Technology Transfer and Construction Industry*

In order for a technological transfer to be very successful in construction, certain criteria must be met. Specialists have introduced products (Industrial House Building solution by Uusitalo and Lavikka, 2020), processes, and knowledge as the basic scientific criteria to be completed (Rameezdeen, Menah and Amaratunga, 2005). In addition, people and culture have recently been introduced as another criterion (Chatterji, 2005). The question that arises here is whether these criteria can be met in the construction industry. Takim, Nawawi and Omar (2015) identified number of barriers to implement on technology transfer as cultural differences, language barriers, social valves, and different objectives.

### *C. The Technologies that transfer through the Construction Technology Transfer*

Construction technology is one of the fastest growing and developing technology in the

world today. Overseas contractors supported in spreading this technology vastly. Globalization and innovation are two mediums that can have a major impact on this rapid growth. Because of this, a new update of technology can be seen tomorrow. According to Anderson and Schaan (2001), construction technology can be discussed in five parts. These same technologies are also being exchanged to some extent through foreign contractors. Therefore, construction technologies exchanged through foreign contractors can be shared in the same way.

In terms of Communication related construction Technology Transfer, this category includes technologies such as emails, digital photography for progress reporting, office to site video links, company computer network related technologies (Anderson and Schaan, 2001) The use of such technology will greatly benefit the construction industry as well as minimize unnecessary project costs. Due to the current corona disaster, these technologies will greatly help to reduce human consumption and keep the project going as usual.

On-site Plant and Equipment related construction Technology Transfer includes such as laser guided equipment, automated systems and programmable machines, Global Positioning Systems related technologies (Anderson and Schaan, 2001). In the case of this, these are used for survey related work (setting out), levelling purposes. Advantages of these technologies include increased productivity, improved safety, shorter workweeks for labour and as disadvantages include possibility to workers becoming slaves to automated machines, human error in the management of these technologies will somehow endanger civilization.

In terms of Material related Technology Transfer, this category includes using high performance concrete, composite materials, recycled plastic components related technologies (Anderson and Schaan, 2001). High performance concrete refers to the types of concrete that are manufactured to achieve high performance through strength or other

desired properties. In the case of composite material, for example, fiber reinforced polymer. Advanced systems related Technology Transfer includes remote sensing and monitoring systems, pre-assembled systems, deconstruction and reuse systems (Anderson and Schaan, 2001). The remote sensing and monitoring systems include such as real time safety monitoring systems, laser scanning systems, and drone technology. In the case of pre-assembled systems, this refers to the design of a system outside the construction project site, bringing it to the project site and assembling and using it (Anderson and Schaan, 2001). Various systems like formwork (Muhammad, 2020) and concrete batching plants can be introduced for this.

Design related Technology Transfer includes such as computer aided designs, modelling and simulation technologies, electronic exchange of computer aided design files (Anderson and Schaan, 2001). Computer aided designs are the use of computer systems to design, modify, analyse, and optimize a design. In terms of modelling and simulating related technologies, modelling is called "the process of producing a representation of the construction and the working of some system of interest" and simulating is called "imitation of the operation of a model of the system". The other type of technology is electronic exchange of computer aided design files. Those exchanging technologies can take as feature recognition tool, non-Parametric modelling method.

#### *D. Foreign Contractors' Construction Technology Transfer on Sri Lankan Construction Industry*

Sri Lankan contractors' weaknesses and impact of globalization can take as the most influenceable aspects for foreign contractors' technology transfer. Sri Lanka is a small island surrounded by the Indian Ocean and has a population of around 22 million. Sri Lanka annually allocates more than Rs. 100 billion to the construction sector. Contractors are a major contributor to the Sri Lankan construction industry. Sri Lanka currently has main

Contractors ranging from CS2 to C9 and the number of contractors in all sectors is over two thousand five hundred. Oke, Aghimien and Adedoyin (2018) say there is a small amount of opportunity and strength for local contractors in developing countries, but many threats and vulnerabilities exist compared to developed countries. Their weaknesses include poor technology applications, poor research and development, low financial and organizational capabilities, and inexperienced expertise. Their threats include low technical innovations and unfavorable government policies. Such threats and vulnerabilities are common to Sri Lanka as well as a barrier to large-scale construction as well as the development of their companies. This situation can only be expected to increase due to the volatile economic situation and political instability in the country.

Globalization has been a hot topic not only in recent times but also in the recent past. Yeates (2002) states that globalization is "the term that has been given to a range of economic, technological, cultural and political forces and processes that are said to have collectively produced the characteristic conditions of contemporary life". Over time, the needs and requirements of each human division became more complex and needed to outperform the other. Due to the complexity of these projects for developing countries, the problematic conditions prevailing within the country and the weaknesses of the local contractors mentioned above, foreign contractors have to be imported to carry out these constructions.

*E. Potential positive effects of construction technology transfer through foreign contractors on Sri Lankan construction industry*

According to Iroegbu (2017), technology transfer to developing countries can enhance the manufacturing process and increase productivity and efficiency in the country. Construction industry is a major part of a country and that means if there is an overall productivity improvement of a country it directly means that there is also a productivity

improvement in their construction industry. According to Piva (2003), Technology catching-up is another one of positive impact of Technology Transfer which helps to enter to the large-scale construction projects within relevant areas. Other one can take as it gives ability to export construction services to overseas countries (Bandara, 2014). This can be confirmed by the fact that Sri Lankan contractors are currently exporting their services to foreign countries. Domestic contractors have been providing their services in states such as the Maldives and Qatar. Next one is that it causes to improve the status of domestic construction firms. Devapriya and Ganesan (2002) states that construction Technology Transfer helps to improve the construction firm's future business. If it can improve the future businesses, then it automatically develops the status of construction firms. Those can take as the potential positive impacts of Technology Transfer on developing countries through the foreign contractors.

*F. Potential negative effects of construction technology transfer through foreign contractors on Sri Lankan construction industry*

Technology transfer can have a positive as well as a negative impact on the Sri Lankan construction industry. There is clear evidence that there are many Indian and Chinese contractors in Sri Lanka today and that they have a large manpower and machineries (Perera *et al.*, 2021). There is some connection between them and the local construction technology exchange because they bring new construction technologies to the country. Thus, they contribute many local constructions and their attendance in local sector is high. They also intervene in projects where local contractors can participate alone. This reduces the number of projects that local contractors must participate and creates a lot of competition among them for other remaining small projects at present there is a certain

decline in the skills of the people employed in the construction industry.

Technological acquisitions through the exchange of technology make it possible to overcome the situation. With the convenience of technology the need for human labour will drop to a very low level. Furthermore, there may be some tendency in the future, for job losses in the construction industry due to the transfer of construction technology. The transfer of technology in the construction industry can have a negative impact on the composition of jobs as well as the wages of those employed (Asia and Pacific, 2018).

Currently, robotic technology is increasingly being used for manual labour, and the use of multifunctional automation machines is gaining momentum. Inequality in income distribution is a major problem in many developing countries today (Dabla-norris and Kochhar, 2015). This disparity in revenue distribution through technology transfer across a particular sector may increase in the future (Muzammil *et al.*, 2018). This is like the situation in the construction industry as a whole. The salaries of people who can handle new construction technologies have the potential to skyrocket, while the salaries of other relief workers could be drastically reduced. As a result, there is a risk of revenue sharing through the technology transfer associated with the construction industry.

Finally past research represented that construction technology transfer as a key benefit can gain through the foreign counterparts and this investigation investigated about the potential impacts that can happen through them.

### 3. Research Methodology

The aim of this paper was to conduct an in-depth study on consequence of foreign funding projects into the local construction industry (primary stakeholders) including secondary stakeholders who are in associated fields. The required information had to be obtained from professionals who had knowledge and experience on direct or supported on foreign funded projects. Bricki and Green (2007) found

that the qualitative research approach is best for collecting opinions and facts from people based on their experience and behavior. However, this research design with mix approach both with qualitative and quantitative method. In order to identify the level of degree of the impact a questionnaire was distributed by using the stratified sampling technique to choose the sample for detailed questionnaire and the purposive sampling technique was used to obtain the semi-structured interview-related samples. The data obtained from the detailed questionnaire were analysed using a variety of techniques. At first step, the alignment of the effects of the data had been analyzed using the Relative Importance Index (RII) methodology and the analysis of Yes / No type problems using percentages. Secondly, use the SPSS software and results were represented through the tables and Pie charts. Finally, use content analysis for analyse the interviews outcome and listed and highlighted for applicable audience reference.

### 4. Result and Discussion

Below analyses flow according to the data gathered through the detailed questionnaire. Planned samples from professionals were: Ten Project Managers; Twenty Site Engineers; Ten Quantity Surveyors; and only five Architects and this brings the total number of respondents to forty-five. But forty-two questionnaires were received before the due date and the remaining three were not received by the researcher. Examining the forty-two questionnaires collected, one of them was incomplete.

Reliability Statistics	
Cronbach's Alpha	N of Items
.819	21

Figure.1: Reliability Statistics

According to SPSS software, Cronbach's Alpha value is 0.819. It proved that internal consistency is good, and the research tool is reliable and will give credible results.

Based on questionnaire, the following technological factors were identified and listed as per prioritization and highly impactable construction technologies which can come to Sri Lanka through foreign contractors.

Table 1: RII of Construction Technologies

	CODE	RII
<b>On-Site Plant and Equipment related construction Technology Transfer</b>		
Laser guided equipment related technologies	ON1	0.6634
Automated systems and Programmable machines related Technologies	ON2	0.8975
Global positioning systems related technologies	ON3	0.6292
<b>Advanced Systems related construction Technology Transfer</b>		
Remote sensing and monitoring systems related technologies	AS1	0.7463
Deconstruction and Reuse systems related technologies	AS2	0.6146
Pre-assembled systems related technologies	AS3	0.6000
<b>Design related construction Technology Transfer</b>		
Computer Aided Design related technologies	DT1	0.8487
Modelling and simulating related technologies	DT2	0.9414
Electronic exchange of CAD files related technologies	DT3	0.6780
<b>Communication related construction Technology Transfer</b>		
E-mail related technologies	CT1	0.5365
Digital photography for progress reporting related technologies	CT2	0.5902
Office-to-site video links related technologies	CT3	0.6634

Company computer network related technologies	CT4	0.5170
<b>Material and Systems related construction Technology Transfer</b>		
High performance concrete related technologies	MS1	0.7024
Composite materials related technologies	MS2	0.5902
Recycled plastic components related technologies	MS3	0.5024

$$\text{Average: } \frac{\sum_{i=0}^n X_i}{n}$$

Equation 1: Average Equation

Source: (Kar, 2010)

$$\sum_{i=0}^n X_i = X_1 + X_2 + X_3 + \dots + X_n$$

$$n = \text{Total number of terms}$$

$$\text{Average of RII} = \frac{\text{RII1} + \text{RII2} + \dots + \text{RII16}}{16}$$

$$= 0.6701$$

The table above shows the potential impact of technologies that can be transferred from foreign contractors into Sri Lanka based on data obtained from the knowledge, experience, and vision of construction professionals. Most impactable technologies are ranked through the RII values of each technologies and only selected the technologies had RII value more than average RII value, as the highly impactable technologies. Most impactable technology can take as the Modelling and simulating related Technologies and second one is the Automated systems and Programmable machines related Technologies and others are Computer Aided Design related technologies, Remote sensing and monitoring systems related technologies, High performance concrete related

technologies, electronic exchange of CAD files related technologies respectively.

The content analyses were conducted, according to the data gathered through the semi structured interviews. There were three categories of stakeholders selected as: project owners; project advisors including design and cost consultants; and contractors which was interviewed three professionals from each group.

The influential stakeholders are the project owners and according to their primary data collection the following results were generated. All most all foreign funded projects were imposed with none negotiated provisions and backwardly benefited to them, i.e. materials are to be purchased from same country; management teams and heavy equipment from same party as well as forcing to appoint a principal contractor. All interviewees satisfied on technology transfer received to the country in their level and appreciate about receiving of modern materials, plant and equipment. Their special concern given that losing of tax component on imported materials and equipment due to granting of tax concessions as per agreed provisions in the building contract which can be treated as negative impact to the local industry. Further added that foreign contractors tend to import excess quantities on materials and equipment through tax concessions for their other projects. The next negative impact was that rejection of imported materials and equipment due to local designer's comment in order to maintain the Sri Lankan codes and standards which becoming waste and uneconomical to return to the originate place.

The outcome related to second category was local consultants and they were very pleased about participation to foreign funding projects because they would able to receive latest modern technology applications where rich countries to apply at present time in order to enhancing modern knowledge during same consultation application. They confirmed that latest project delivery approach by on Building Information Model (BIM) based strategy which serve long term value of asset information from earliest concept to demolition during a project

life cycle. As per their view this application able to alignment with client asset management strategy which serve about long range business goals and further said that information is digitalizing by computer base automated software application and arrange common data platform to share and use by authorized stakeholders and generating data and handling by non-proprietary data server. They were keen on adaptation to the BIM project delivery method as individual parties' involvement through their own sophisticated computer application (ex. Architect by 3D model AutoCAD design; engineers by Revit; and cost consultant to apply by CostX and the like).

The interviewees who were from contractors' party also given positive comments on participation of foreign funded projects. Their main concern was how to handle the procurement (bidding) practices through e-commerce as demanded by the project owners. One interviewee was estimating manager from reputed construction organization and given his experience on 'e-practicing' on bidding with his team and express that main barrier to adopt to the system was lack of training on his system (combing design information to the value calculation by way of sophisticated computer software packages). Second interviewee was Contractor's project manager and informed that most of project administration was under the prolog computerized system and occurred to adopt it sooner to continue progress of works. And also, modern developed building components were part of the work to execute and special training was demanded by the service provider from the funded country and therefore special programme to adopt selected technical staff in order to educate them. Another point was that building services operational manual was not in common language and translator was appointed to cater the situation. Thirdly, interviewed the manager on purchasing department on another construction organization and given his experience on his department contribution on foreign funded project in Maldives where project execution was by Sri Lankan contractor. Solution taken to that project was an adopting

by ERP (Enterprise Resource Planning) system by way of procurement of materials, goods, plant and equipment. He pointed out that electronic application is not fully supported in legal principles currently exist and authentication of transaction is jape dice from unauthorized parties.

In the industry now right time is to transfer gained their knowledge to local projects in Sri Lankan context. All contractors' representatives raised that allowing capital on adopting those system are costly and government has to involve on policy decision and action plan to implement on it.

According to experts' given findings, there were significant suggestions to improve transferring of technology to the country and also highlighted importance about how to reduce those negative effect as well to address in this report.

## 5. Conclusion and Recommendations

The aim of this paper was to identify construction technologies that have the greatest impact on the Sri Lankan construction industry through possible foreign contractors' technology transfer through participants. In addition, it explores the potential positive and negative effects of technology transfer on local construction industry through one of subjective and explores possible ways of mitigating the potential negative impact of technology transfer on future Sri Lankan construction industry.

Conclusion was set out based on recommendations given through the industry experts that can be described as follows. The participated local construction organizations were gained extensive benefits through modernly developed materials on building constructions (mainly in finishes and building services plant and equipment). It facilitates to identify environmental friendly and cost benefited goods based on life cycle cost application rather than using traditional goods on decays. Challenges were on: special training sessions were on technical staff to carry out maintenance of permanent system; appointment of language translators to prepare

operational and maintenance manual including other reports; adopting electronic base bidding process; application of BIM practices with new software programmes. There are negative impact create as well: monopoly of trading where only few contractor's would benefited new system and not distributing to the other local competitors; the cost of spare parts would be costly on future due to the fixing of special system; shutdown period can occur at any time and overhauling events to consider on maintenance; construction organization to spend additional capital cost to adopt new systems to the existing process; maintain on software license in long run basis. There are many opportunities creates in the field of computer software programmes and need more training centers to facilitate the requirement. Specially, the development of legal principles on e-commerce is to a prime action to be taken.

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